A. Heading attitude reference set (HARS) system

1. The HARS system is an attitude heading reference system that operates with the doppler navigation system to provide pitch, roll, and heading data to the helicopter avionics.

   a. Magnetic signals to the RMI, HSI, and doppler signal data converter (SDC).

   b. Angular rates, angular acceleration, linear acceleration, and hover display data to the fire control computer (FCC). The VDU, ORT, and HMD's receive heading and attitude information.

   c. Pitch and roll signals to the doppler SDC and remote attitude indicator (RAI).

2. The HARS is capable of ground and in-flight alignment.

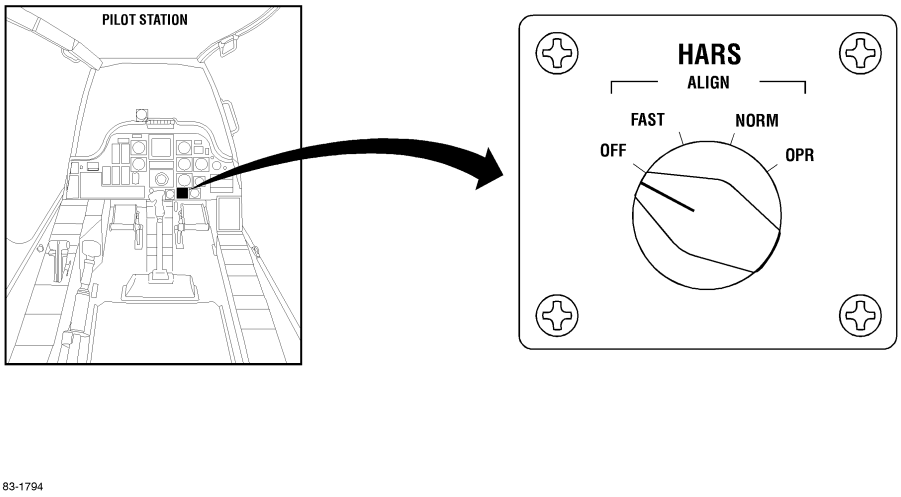
3. Major components

   a. HARS mode control panel

   b. HARS AN/ASN-143

071-6

HARS MODE CONTROL PANEL



NOTES

B. Component purpose, location, description, and operation

1. HARS mode control panel

a. Gives the pilot on-off control of the HARS.

b. Gives the pilot the ability to select the alignment mode.

2. Mounted on the pilot's lower right instrument panel.

3. HARS mode control panel functions

a) OFF - system is de-energized

b) ALIGN - system is placed in the inertial alignment mode

(a) FAST ALIGN

1) Rapid single-position gyrocompass alignment

2) Four to six minutes alignment time

3) Accuracy is degraded in this mode

(b) NORM ALIGN

1) Two-position gyrocompass alignment

2) Six to nine minutes alignment time

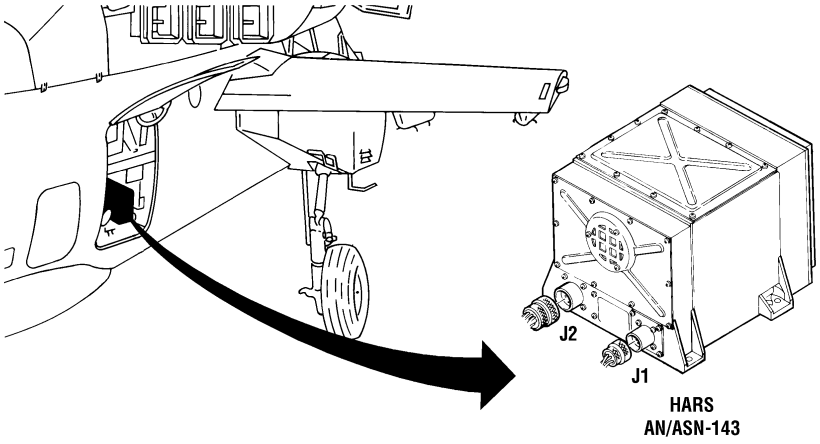
3) Increased accuracy (most accurate if performed prior to engine start)

4) OPR

a) This position is selected after the alignment has been accomplished.

b) This is the operating mode; all outputs from the HARS are available.

HARS AN/ASN-143



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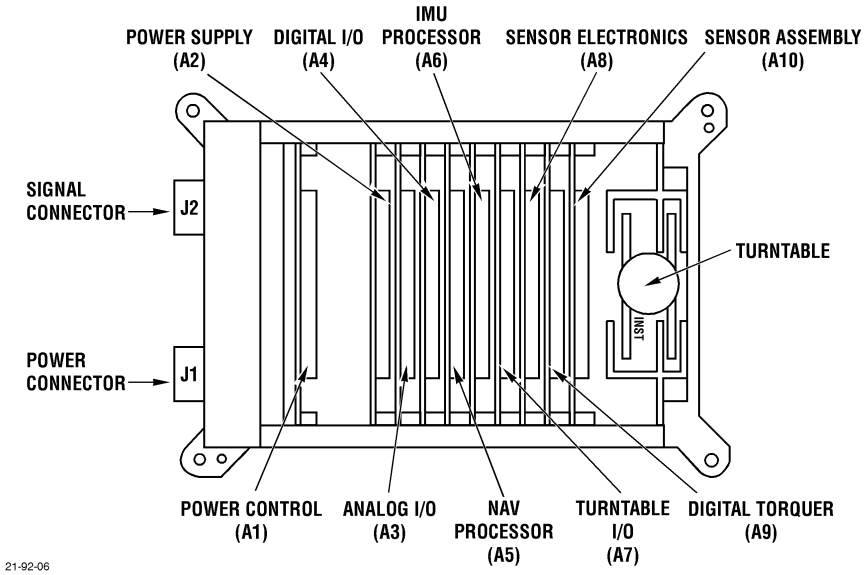
NOTES

4. HARS (AN/ASN-143)

   a. Provides outputs that are proportional to pitch, roll, and magnetic heading.

   b. The HARS is mounted to the HARS support structure on the bottom, forward portion of the aft avionics bay. The structure is precision aligned by a laser boresight process. The HARS boresight correctors that are entered into the FCC are determined by the this laser boresight process. Any damage or maintenance actions that remove the HARS support structure necessitate that the support structure be realigned by the laser boresight process, new correctors determined and entered into the FCC.

HARS MODULE LOCATION



NOTES

c. Description

(1) External components

(a) J1 - provides signal connection

(b) J2 - provides power application

(c) Cooling fan - provides forced air cooling for the HARS internal components.

(2) Internal components

(a) Power control card (A1)

1) Generates voltages required by the HARS sub-modules.

2) Generates the signal required to enable the heaters on the sensor assembly.

(b) Power supply card (A2)

1) Develops voltages required by the HARS electronics.

2) Develops 3-phase spin signals for the gyros.

(c) Analog I/O card (A3) - converts digital data into analog outputs to power the synchros and indicators in the aircraft system.

(d) Digital I/O card (A4)

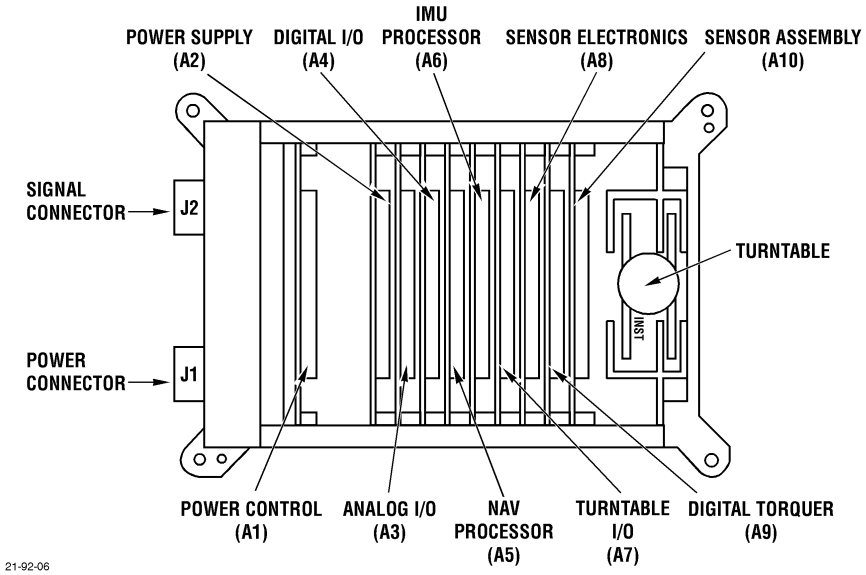
1) Accepts and provides digital information to various aircraft systems via a bi-directional serial digital data bus.

2) Contains logic for use with an external control panel.

(e) NAV processor card (A5) - controls the exchange of information between the HARS and the helicopter's avionics.

(f) IMU processor card (A6) - controls the operation of the sensor assembly (A10).

HARS MODULE LOCATION



NOTES

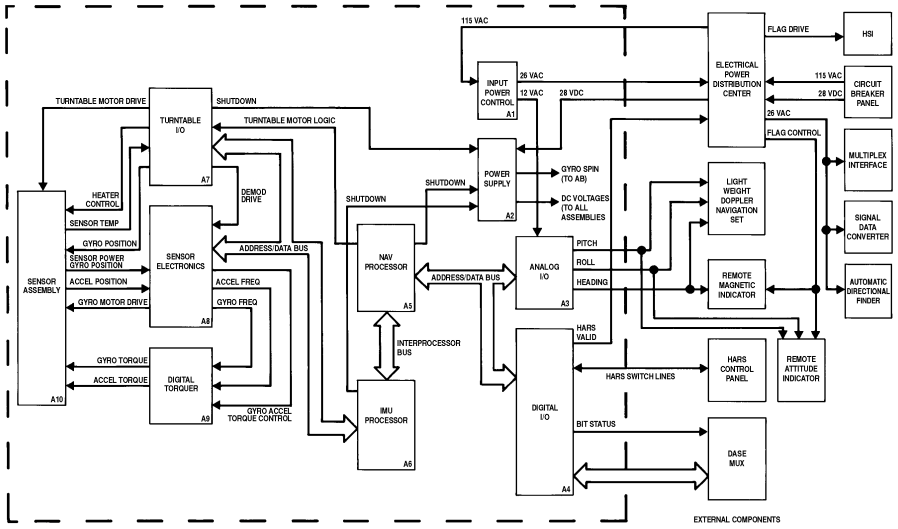
(g) Turntable I/O card (A7) - converts inputs from the sensor assembly to a useable form for use by circuit cards that utilize its information.

(h) Sensor electronics card (A8) - converts gyro and accelerometer signals into Pulse Width Modulated (PWM) wave forms.

(i) Digital torquer card (A9) - provides precision torquing current to the gyro and accelerometer torquing axes to maintain these components in a null state.

(j) Sensor assembly (A10) - performs the primary function of orienting the inertial sensors to each other.

HARS OPERATIONAL BLOCK DIAGRAM



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NOTES

d. Operation

(1) Input power

(a) 28 VDC is applied from the HARS DC circuit breaker located on the pilot's forward circuit breaker panel through the electrical power distribution center to the power supply assembly (A2).

(b) 115 VAC is applied from the HARS AC circuit breaker located on the pilot's forward circuit breaker panel through the electrical power distribution center to the power control assembly (A1).

(2) Input power control (A1) - supplies 12 VAC to the analog input/output (A3) and 26 VAC to external equipment via the electrical power distribution center.

(3) Power supply (A2)

(a) Inputs

1) Internal protection circuits shut off the power supply when the input voltage is too high, the output current is too high, or the output voltages are too high or too low.

2) These shutdown signals are applied from the:

a) NAV processor (A5)

b) IMU processor (A6)

c) Turntable I/O card (A7)

(b) Outputs

1) Supplies gyro spin signals to the sensor assembly (A10) for use by the gyros.

2) Supplies various DC voltages to the HARS.

a) +5 VDC at 3.8 amperes

b) +7 VDC at 0.7 amperes

c) -7 VDC at 2.15 amperes

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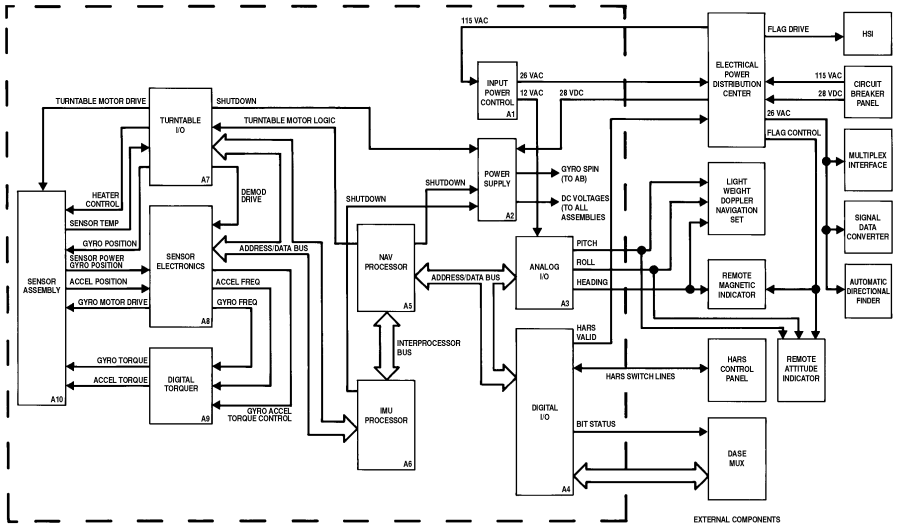
HARS OPERATIONAL BLOCK DIAGRAM



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NOTES

d) +12 VDC at 1.4 amperes

e) "15 VDC at 0.3 amperes

f) +20 VDC at 0.7 amperes

g) "25 VDC at 0.05 amperes

h) +30 VDC at 0.02 amperes

(4) Sensor assembly (A10)

(a) Contains two gyros, three accelerometers, a calibration circuit card, and heater element.

1) The gyros and accelerometers react to any change in aircraft motion or attitude. These changes are detected by position sensors.

2) The gyros and accelerometers are returned to their original positions by the digital torquer circuit (A9) after they have reacted to a change.

3) The calibration circuit card contains a programmable read only memory (PROM) which stores the calibration data for the gyros and accelerometers.

4) The heater elements maintain a stable temperature inside the assembly.

5) The gyros and accelerometers are mounted on a turntable which is positioned during ground alignment.

(b) Inputs

1) Gyro motor drive signals from the sensor electronics assembly (A8).

2) Gyro position sensor power signal from the turntable I/O card (A7).

3) Gyro and accelerometer torque signals from the digital torquer assembly (A9).

4) Heater control signals from the turntable I/O card (A7).

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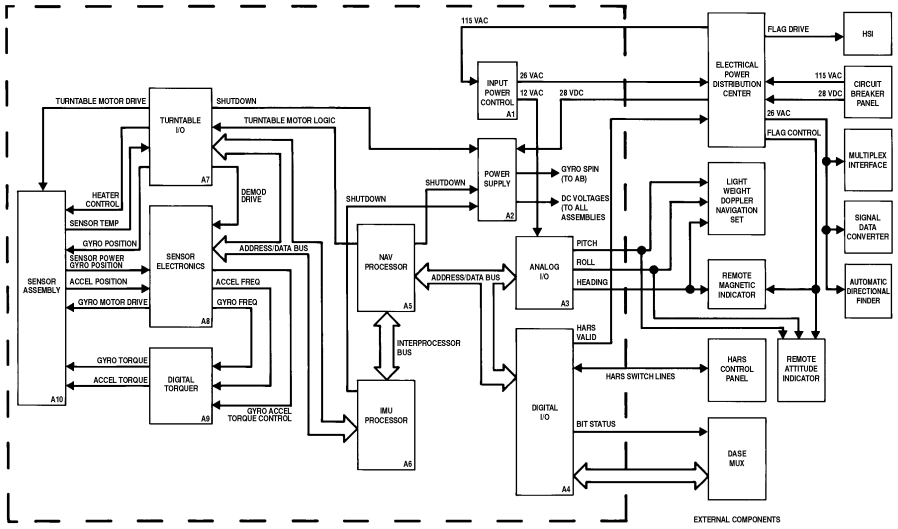
HARS OPERATIONAL BLOCK DIAGRAM



NOTES

5) Turntable motor drive signal from the turntable I/O card (A7).

(c) Outputs

1) Gyro and accelerometer position signals to the sensor electronics assembly (A8).

2) Sensor temperature signal to the turntable I/O card (A7).

(5) Sensor electronics assembly (A8)

(a) Processes gyro and accelerometer position information.

1) Position signals are received from the sensor assembly (A10).

2) The sensor electronics card (A8) converts the position signals into frequencies.

3) The value of the frequency depends on how far the gyro or accelerometer has moved away from its normal position.

4) The sensor electronics card (A8) also generates gyro and accelerometer torque rate control signals.

(b) Inputs

1) Gyro and accelerometer position signals from the sensor assembly (A10).

2) Control signal from the inertial measuring unit (IMU) processor (A6).

3) Demodulation drive signals from the turntable I/O card (A7).

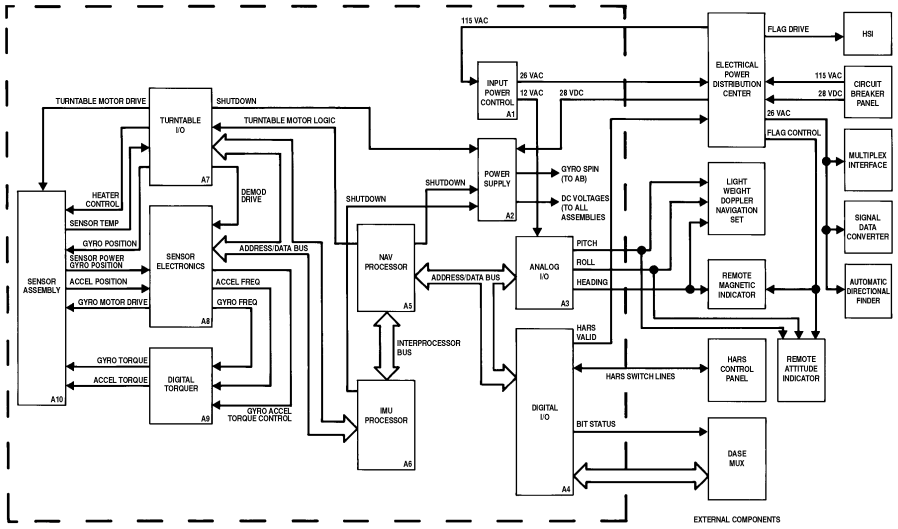
(c) Outputs

1) Gyro and accelerometer position frequencies to the digital torquer assembly (A9).

2) Gyro and accelerometer torque rate control signals to the digital torquer assembly (A9).

3) Gyro and accelerometer position information to the inertial measuring unit (IMU) processor (A6).

HARS OPERATIONAL BLOCK DIAGRAM



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NOTES

(6) Digital torquer assembly (A9)

(a) Generates precision torquing signals for the gyros and accelerometers and contains a memory circuit which stores calibration values for the torque circuits.

(b) Inputs

1) Gyro and accelerometer position frequencies from the sensor electronics assembly (A8).

2) Gyro and accelerometer torque rate control signals from the sensor electronics assembly (A8).

(c) Outputs - provides gyro and accelerometer precision torquing signals to the sensor assembly (A10).

(7) Turntable I/O (A7)

(a) Contains heater control circuits, a mission data memory, a gyro position sensor power circuit, turntable motor drive circuit, and a self test circuit.

1) The heater control circuits control temperatures in the sensor assembly (A10).

2) The mission data memory consists of a random access memory (RAM) which stores accelerometer data obtained from the most recent two-position gyrocompass alignment. This data is used to help in processing accelerometer signals and in future alignments.

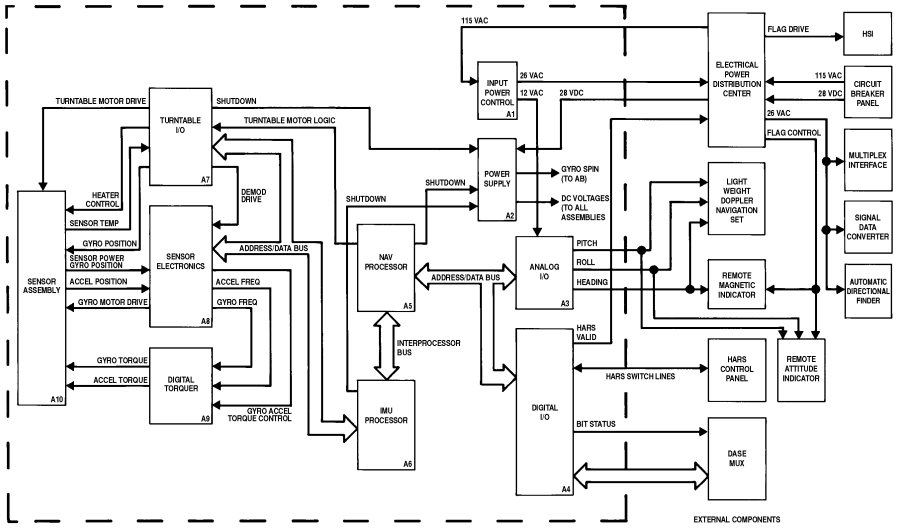
3) The gyro position sensor power circuit supplies a stimulation signal to the gyro position sensor.

4) The turntable motor drive circuit supplies motor drive signals to the turntable.

5) The self test circuits monitor power supply voltages, sensor assembly temperatures, gyro and accelerometer rate signals for out of tolerance conditions.

a) If these signals are out of tolerance a shutdown signal is generated.

HARS OPERATIONAL BLOCK DIAGRAM



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NOTES

b) Six light-emitting diodes are mounted on the top edge of the turntable.

c) These diodes are used to indicate HARS failures detected by the NAV processor card (A5) or the IMU processor card (A6).

(b) Inputs

1) Sensor temperature signals from the sensor assembly (A10).

2) Control signals from IMU processor (A6).

3) Turntable motor logic from the NAV processor (A5).

(c) Outputs

1) Heater control signals to the sensor assembly (A10).

2) Gyro position sensor power to the sensor assembly (A10).

3) Turntable motor drive to the sensor assembly (A10).

4) Temperature, mission data memory, gyro and accelerometer information to the IMU processor (A6).

5) Shutdown signal to the power supply (A2).

6) Demodulation drive signals to the sensor electronics assembly (A8).

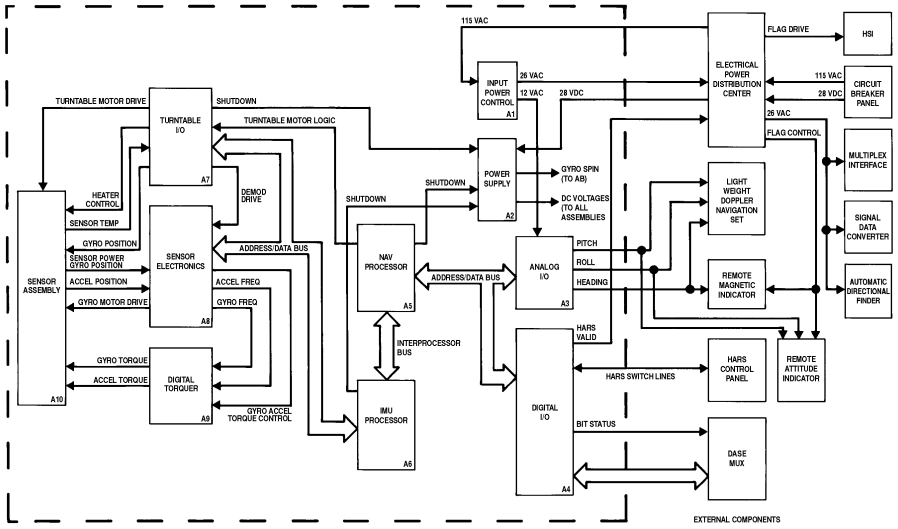
(8) Inertial measuring unit (IMU) processor card (A6)

(a) Contains a microprocessor, memory circuits, and input/output circuits.

(b) The main function of the card is to control the sensor assembly (A10).

(c) The microprocessor performs all the necessary calculations for the operation of the sensor assembly (A10).

HARS OPERATIONAL BLOCK DIAGRAM



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NOTES

1) The microprocessor is controlled by instruction stored in PROM.

2) A RAM is used to temporarily store data and results of calculations.

(d) The input/output circuits receive data and transmit control signals to the turntable I/O card (A7), and sensor electronics assembly (A8).

(e) The IMU processor also contains a RAM which is used to send and receive data from the NAV processor (A5).

(f) Contains monitoring circuits which can shutdown the HARS in case a failure occurs.

(9) NAV processor (A5) - the navigation (NAV) processor card (A5) contains the same circuitry as the IMU processor.

(a) The main function of the NAV processor is the management of the input/output signals to and from the HARS.

(b) The processor communicates with the IMU processor through a RAM.

(c) Provides the turntable motor logic signal to the turntable I/O card (A7).

(d) Contains monitoring circuits which can shutdown the HARS in case a failure occurs.

(10) Analog I/O card (A3)

(a) The analog I/O card receives digital pitch, roll, and heading information from the NAV processor (A5).

(b) The analog I/O card converts this into synchro format for output.

1) Pitch, roll, and heading signals are sent to the light weight doppler navigation set.

2) Pitch and roll signals are sent to the remote attitude indicator.

3) Heading signal is sent to the remote magnetic indicator.

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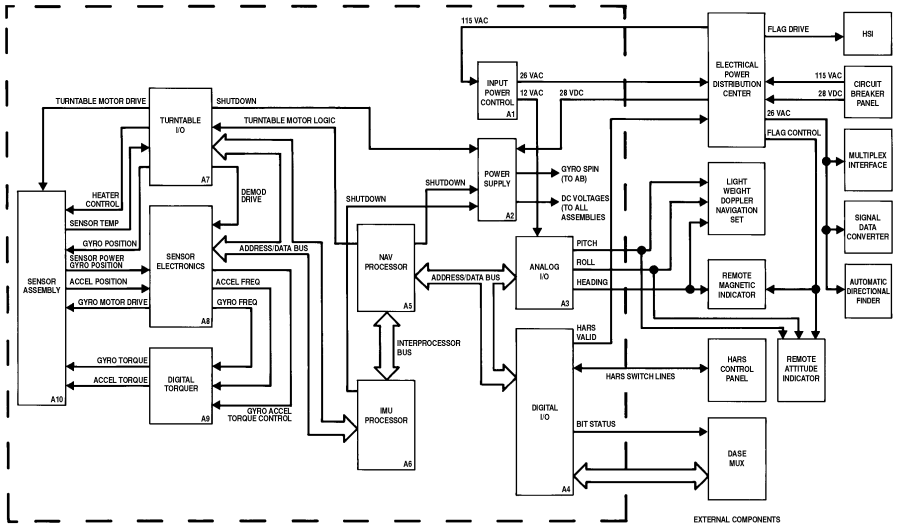
HARS OPERATIONAL BLOCK DIAGRAM



NOTES

(11) Digital I/O card (A4)

(a) The digital I/O card (A4) contains circuits which communicate with the HARS control panel and the digital automatic stabilization equipment (DASE).

(b) The HARS switch line allows the mode of operation to be determined.

1) The signal allows the control panel to control the operation of the HARS.

2) Three signals control the HARS through the control panel.

a) Fast align

b) Normal align

c) Operate

(c) Two status signals that are generated. They are BIT status and HARS valid.

1) HARS valid signal is provided by the digital I/O to the various flight instruments via the electrical power distribution center. When this signal is lost, the off warning flags on the Horizontal Situation Indicators (HSI), the Remote Magnetic Indicator (RMI) and the Remote Attitude Indicator (RAI) come into view.

2) A bit status signal tells the DASE that the serial data bus does not have parity errors. This is used to determine if the HARS is in a GO or NO-GO condition determined by FD/LS.

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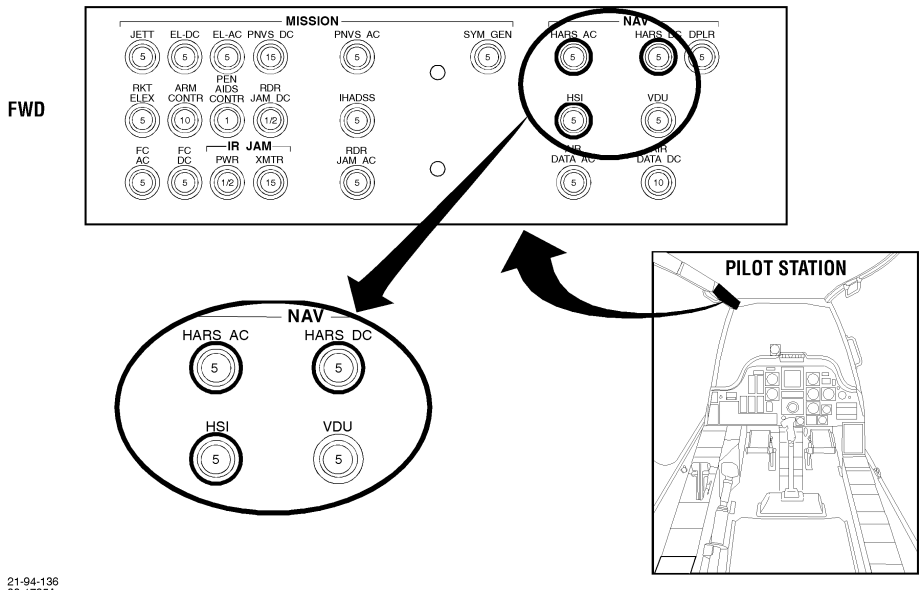
HARS AND HSI CIRCUIT BREAKERS



NOTES

C. Interface Components

1. Circuit protection

a. Provides circuit protection for the HARS.

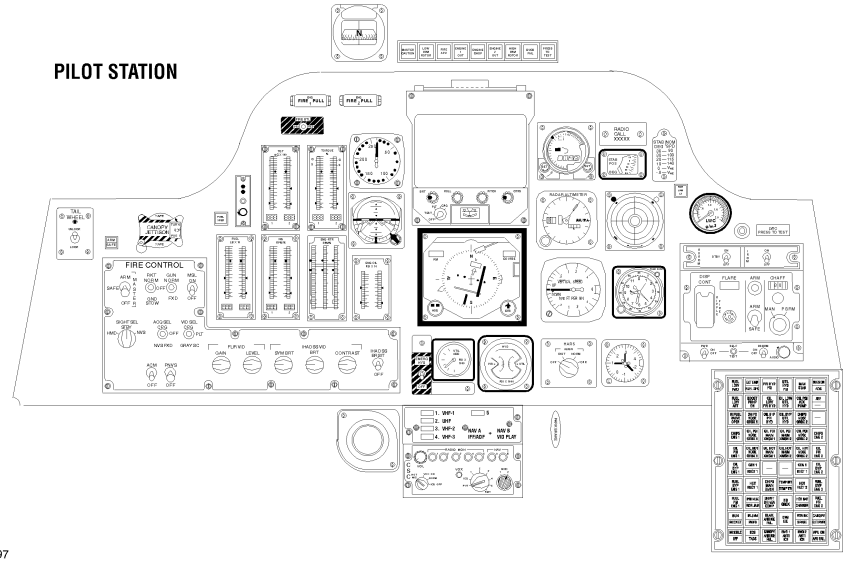
b. The HARS (AC, DC) and Horizontal Situation Indicator (HSI) circuit breakers are located on the pilot's forward circuit breaker panel.

2. The HARS system circuit breakers are rated at 5 amps.

3. Flight reference instruments interface

a. Horizontal Situation Indicator (HSI)

HSI LOCATION



NOTES

(1) Provides the pilot with visual heading and attitude reference data.

(2) Located in the center of the pilot's instrument panel directly under the Video Display Unit (VDU).

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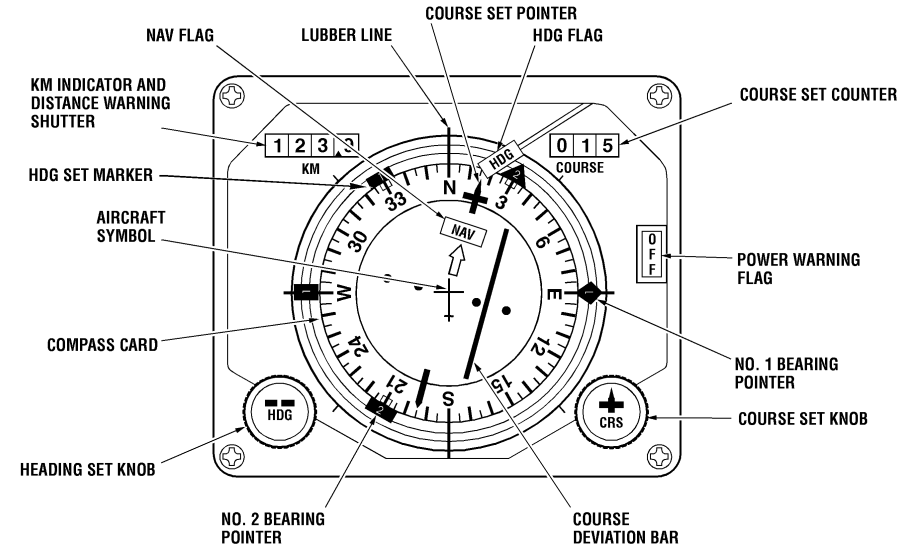
HSI CONTROLS AND INDICATORS



NOTES

(3) HSI indicators and controls

(a) Lubber line - at the top of the dial for compass reference.

b) HDG flag - retracts when a reliable heading signal is available from the HARS.

c) Course set pointer - turns with compass card and is centered on the lubber line when the helicopter is flying the selected course.

(b) Course set counter - digital readout of course as set by the course set knob.

(c) Power warning flag - indicates failure of input power or internal power supply by reading OFF.

(d) HDG select marker - positioned around the compass card by the heading set knob.

(e) Course deviation bar - moves from side to side.

(f) Course set knob - positions course set pointer and course set counter.

(g) No. 1 bearing pointer - provides bearing to destination from lightweight doppler navigation system (LDNS).

(h) Heading set knob - positions heading select marker.

(i) No. 2 Bearing pointer - provides automatic direction finder (ADF) bearing to station information.

(j) Compass card - 360-degree scale that turns to display heading data obtained from the HARS.

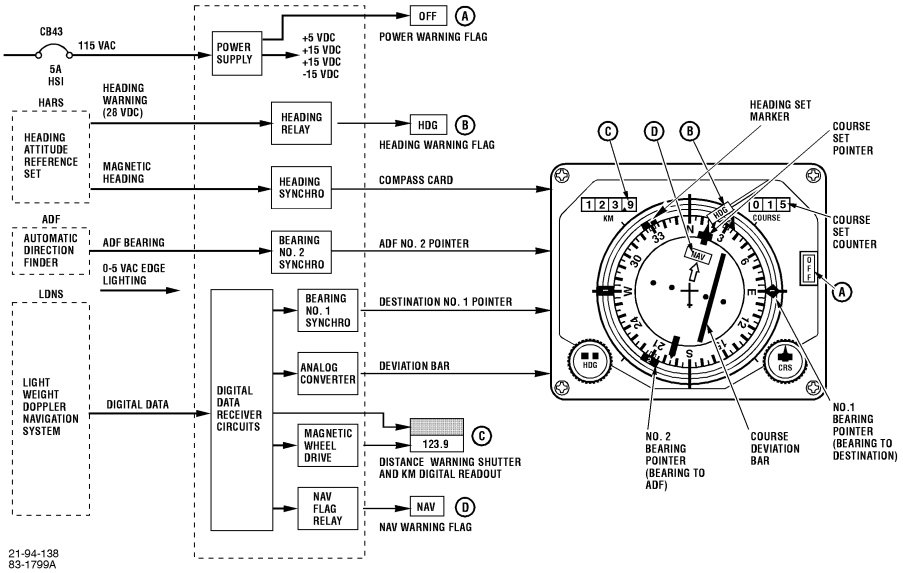
(k) Fixed aircraft symbol - in the center of the compass card and aligned with the lubber line.

(l) Kilometer (KM) indicator - digital readout in kilometers of distance to destination.

(m) Distance warning shutter - retracts when the "distance-to-destination" signal from the doppler is valid.

(n) NAV flag - retracts from view when a reliable course deviation signal is available from the doppler.

HSI INTERFACE



NOTES

(4) Operation

(a) The HSI has an input power of 115 VAC. If input power is lost or the power supply fails, the power warning flag indicates OFF (A).

(b) The HARS ready/valid signal applies 28 VDC to the HSI heading relay.

(c) The compass card is positioned by the heading synchro signal from the HARS.

(d) The ADF bearing is applied to the number 2 synchro controlling the number 2 pointer.

(e) The No. 1 pointer shows bearing to destination from the LDNS.

(f) The deviation bar shows deviation from the course selected by the CRS select knob. The bar is driven by the LDNS.

(g) The distance to destination is displayed in kilometers and is driven by the LDNS via the magnetic wheel drive.

(h) If the data from the LDNS is not valid, the distance warning shutter partially obscures the display.

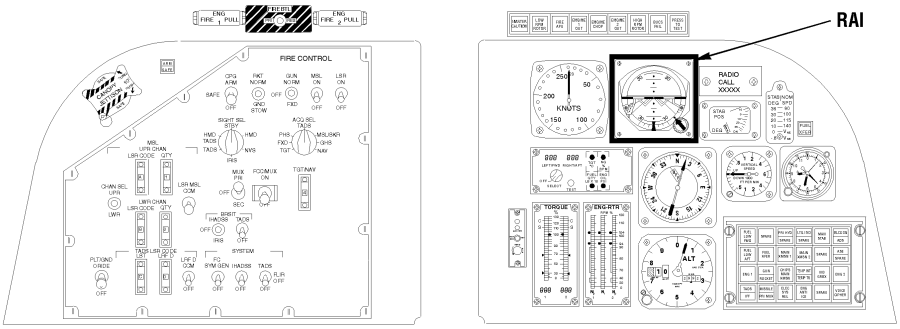
(i) The HSI has two control knobs.

1) Course set knob - moves the course set pointer. The selected course is numerically displayed on the course set counter.

2) Heading set knob - sets the heading select marker, which rotates with and is read against the compass card.

RAI LOCATION

CPG STATION



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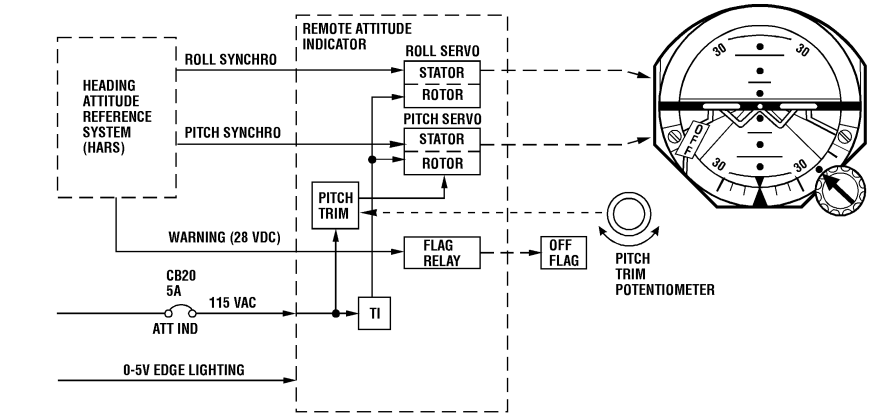
NOTES

b. Remote attitude indicator (RAI)

(1) Displays aircraft attitude in pitch and roll.

(2) The RAI is located on the right half of the CPG instrument panel.

RAI INTERFACE



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NOTES

(3) Operation

(a) The roll synchro signal drives the roll servo. The roll servo mechanically rotates the sphere in the roll axis.

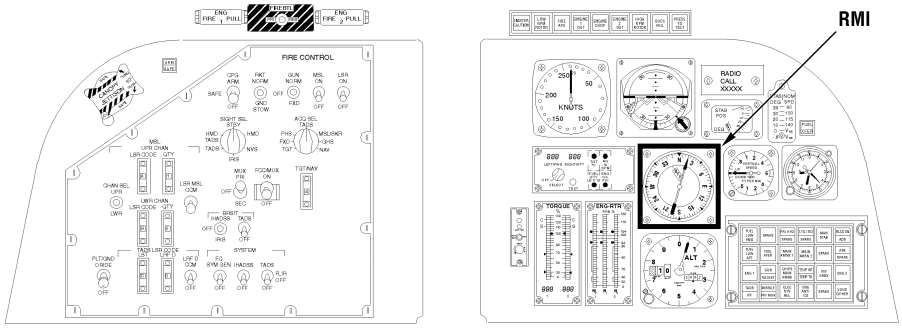
(b) The pitch synchro signal drives the pitch servo. The pitch servo positions the sphere up or down in the pitch axis.

(c) The pitch trim knob is used to adjust the horizon line before flight.

(d) If the HARS malfunctions the flag relay de-energizes, allowing the OFF flag to be displayed.

RMI LOCATION

CPG STATION



83-3204A

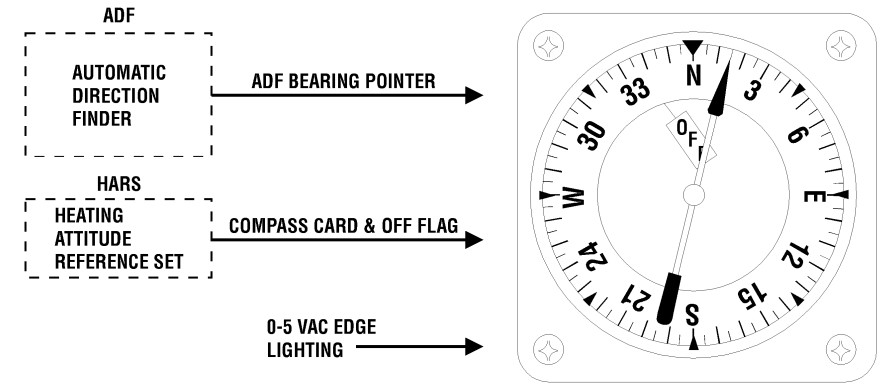
NOTES

c. Radio magnetic indicator (RMI)

(1) Receives magnetic heading information from the HARS and displays this information on a rotating compass.

(2) The RMI is located on the right half of the CPG instrument panel.

RMI INTERFACE



NOTES

(3) Operation

(a) The dial pointer displays relative bearing to the selected ADF station.

(b) The compass card displays magnetic heading from the HARS.

(c) If the HARS data is invalid, the OFF warning flag appears.

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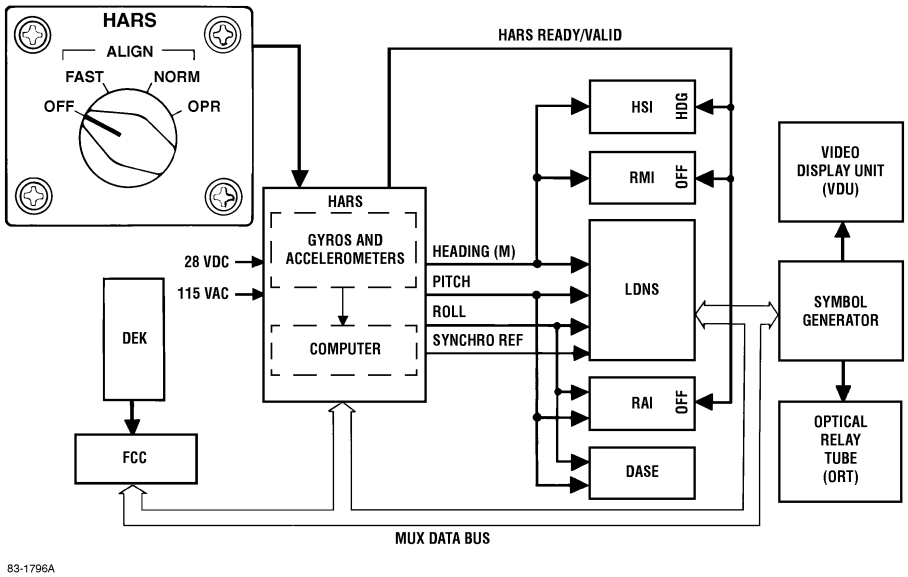
HARS SYSTEM BLOCK DIAGRAM



NOTES

D. HARS system operation

1. The HARS input voltages are

   a. 28 VDC - used for development of various internal DC operating voltages.

   b. 115 VAC - used for

      (1) Synchro excitation

      (2) Cooling fan

      (3) Heater

2. The mode control switch controls

   a. Power application

   b. Alignment mode

      (1) Fast align

      (2) Norm align

   c. Operation

3. Data entry keyboard (DEK) is hardwired into the fire control computer (FCC).

   a. Magnetic variation and latitude must be entered manually into the DEK prior to alignment.

   b. The FCC stores and, when required, applies the magnetic variation and latitude data via the mux bus to the HARS computer.

4. Accurate doppler velocities are received from the lightweight doppler navigation system (LDNS), via the MUX bus, and are used to dampen the inertial system velocities. The stabilization of the inertial system makes the entire system (doppler/inertial) more accurate than either system by themselves.

5. The HARS internal gyros sense changes in the helicopter attitude, and internal accelerometers sense changes in the helicopter movement. The sensors feed directly into the HARS computer.

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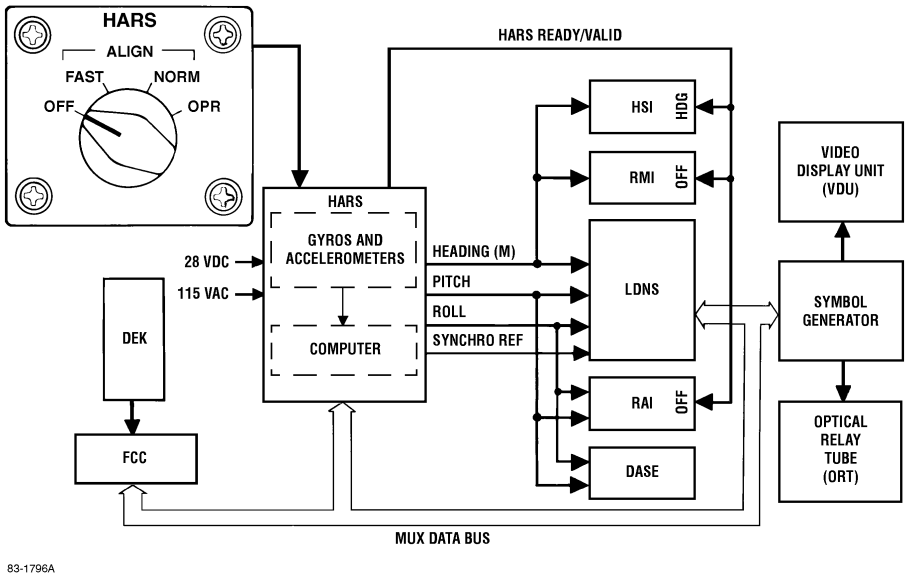
HARS SYSTEM BLOCK DIAGRAM



NOTES

6. HARS computer outputs

    a. Analog signals

        (1) Pitch

        (2) Roll

        (3) Heading

    b. Digital signals

        (1) Pitch

        (2) Roll

        (3) Heading

    c. Synchro ref - 26 VAC signal used by LDNS.

7. HARS computer outputs are provided to the aft avionics module matrix and then are applied to helicopter systems.

    a. Horizontal situation indicator (HSI) - heading

    b. Remote attitude indicator (RAI)

        (1) Pitch

        (2) Roll

    c. Radio magnetic indicator (RMI) - heading

    d. Lightweight doppler navigation system (LDNS)

        (1) Heading

        (2) Pitch

        (3) Roll

        (4) Synchro ref

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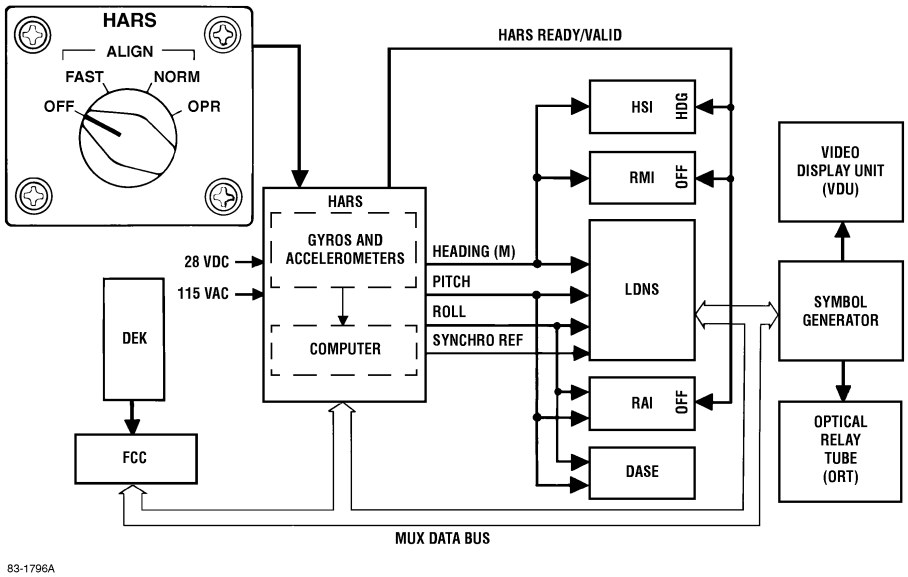
HARS SYSTEM BLOCK DIAGRAM



NOTES

e. Digital automatic stabilization equipment (DASE)

(1) Pitch

(2) Roll

8. HARS ready/valid signal indicates

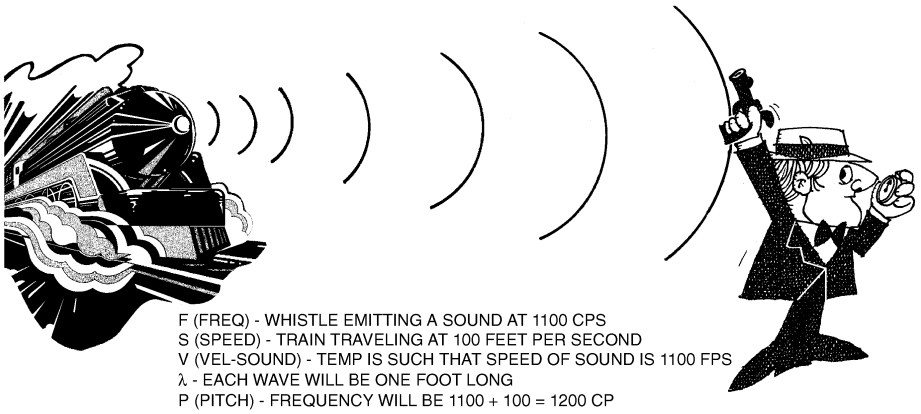
a. The gyros are aligned and the pitch, roll, and heading outputs are valid. The read/valid signal is 28 VDC in a good condition.

b. Controls the Heading Flag (HDG) on the HSI and the OFF flag on the RMI and RAI.

9. The HARS provides flight reference symbology to the video display unit (VDU) and the optical relay tube (ORT) via the MUX and from the symbol generator.

071-6

DOPPLER EFFECT



F (FREQ) - WHISTLE EMITTING A SOUND AT 1100 CPS
S (SPEED) - TRAIN TRAVELING AT 100 FEET PER SECOND
V (VEL-SOUND) - TEMP IS SUCH THAT SPEED OF SOUND IS 1100 FPS
λ - EACH WAVE WILL BE ONE FOOT LONG
P (PITCH) - FREQUENCY WILL BE 1100 + 100 = 1200 CP

$$\lambda = \frac{V}{F} = \frac{1100\ CPS}{1100\ FPS} = 1\ FOOT$$

$$P = F\ \frac{V}{V - S}\quad \text{FOR A SOURCE MOVING TOWARD LISTENER}$$

$$P = F\ \frac{V}{V + S}\quad \text{FOR A SOURCE MOVING AWAY FROM LISTENER}$$

21-94-122
21-90-17

NOTES

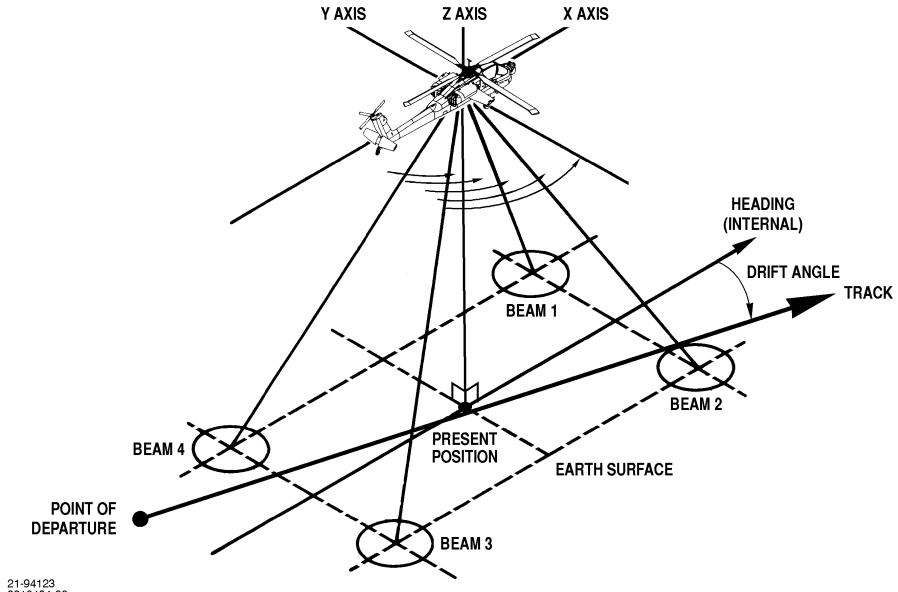
A. The Doppler Effect is the change in the observed frequency of an acoustic or electromagnetic wave due to relative motion of source and observer.

1. The observed frequency is higher than the source frequency as the source approaches the observer.

2. The observed frequency is lower than the source frequency as the source travels away from the observer.

071-(

DOPPLER PRINCIPLES



NOTES

B. Doppler navigation system

1. A doppler navigation system performs dead reckoning navigation automatically and gives a continuous indication of current position by integrating the speed and the drift angle of the helicopter. These are derived from the measurement of the doppler effect of the received echoes from directed, transmitted beams of RF energy from the doppler navigation set. The doppler navigation set output is usually combined with the output from an inertial navigation set, that provides measurement of direction (heading), pitch, roll and yaw information and velocity components. A computer uses the doppler velocity and drift angle, along with the inertial information, to provide distance traveled from the point of departure.

2. Description

a. The radar signal reflected from the ground is shifted in frequency as a function of angle and speed. The shift in frequency is $f_o = (f_o/c)v \cos y$, where f_o is the carrier frequency, v is aircraft ground speed, y is the depression angle of the antenna, and c is the velocity of propagation (approximately 300×10^3 kilometers per second for electromagnetic energy).

b. A single antenna would only allow measurement of one component of the helicopter velocity relative to the direction of radiation. A minimum of three non-coplaner beams are needed to determine the vector velocity.

c. The vector velocity is measured relative to the antenna; therefore, vertical velocity and heading must be known. This is used by a computer to calculate the ground velocity components. If the antenna is not stabilized, inputs of pitch and roll are also required.

d. A four antenna system, called a Janus system, is a much more accurate system. If the helicopter's velocity vector is not in the same direction as aircraft heading, the two forward beams are not the same. This difference is used to calculate the drift angle and speed along the ground track.

e. The use of the forward two beams in conjunction with the aft two beams results in considerable improvement in accuracy.

f. The Janus system can be operated incoherently by using the same transmitter to feed a pair of beams simultaneously. Typically, one beam is directed ahead and to the right of the ground track and the other aft and to the left. A forward-left and aft-right are also fed by the transmitter as a second channel. The two channels can be operated simultaneously or time shared. This method does not require a stable transmitter frequency.

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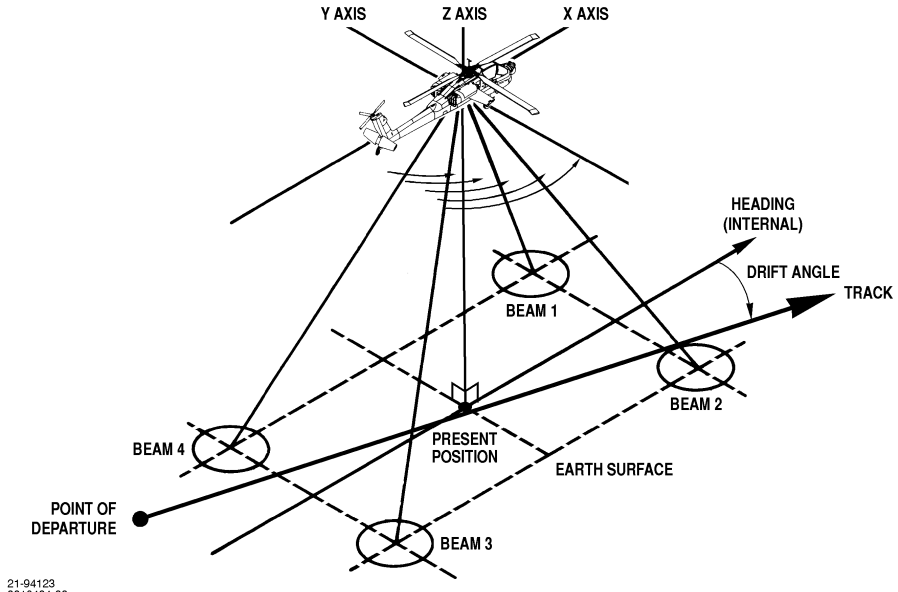
DOPPLER PRINCIPLES



NOTES

3. Operation

a. As the helicopter flies forward:

(1) The returned frequency of the forward beams compress.

(2) The returned frequency of the aft beams expand.

b. By convention beam 1 is compared to beam 3 and beam 2 is compared to beam 4.

(1) The difference between beams 1 and 3 give the velocity of the helicopter over the ground.

(2) The difference between beams 2 and 4 also give the velocity of the helicopter over the ground.

(3) The two beam pairs (1, 3 and 2, 4) can be compared to give drift rate.

(a) If there is no drift rate, the velocity from both beam pairs is equal.

(b) If there is a drift rate, the velocity from both beam pairs is not equal. The difference in velocity between beam pairs is the drift rate, drift direction is toward the beam pair with the highest velocity.

(c) As shown, the returned frequency from beam pair 2, 4 is higher than 1, 3. This indicates a right drift.

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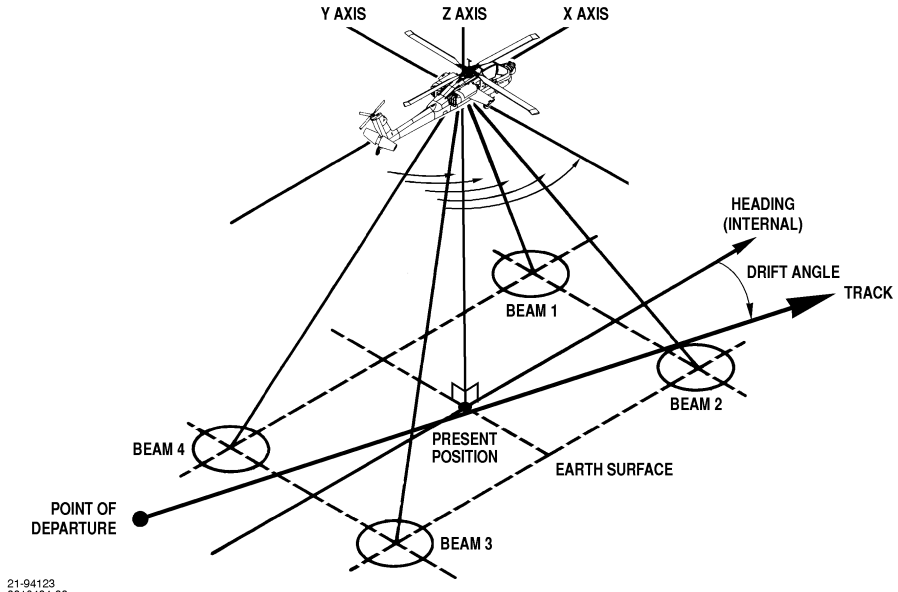
DOPPLER PRINCIPLES



NOTES

C. Advantages of a doppler navigation system

1. It provides continuous velocity and position with respect to the ground.

2. Completely self contained and requires no ground stations.

3. Doppler average velocity information is extremely accurate.

D. Doppler navigation system errors

1. Doppler systems are dependent on an external sensor, such as an inertial system, for azimuth information.

2. The position information derived from a Doppler system degrades as the distance traveled increases.

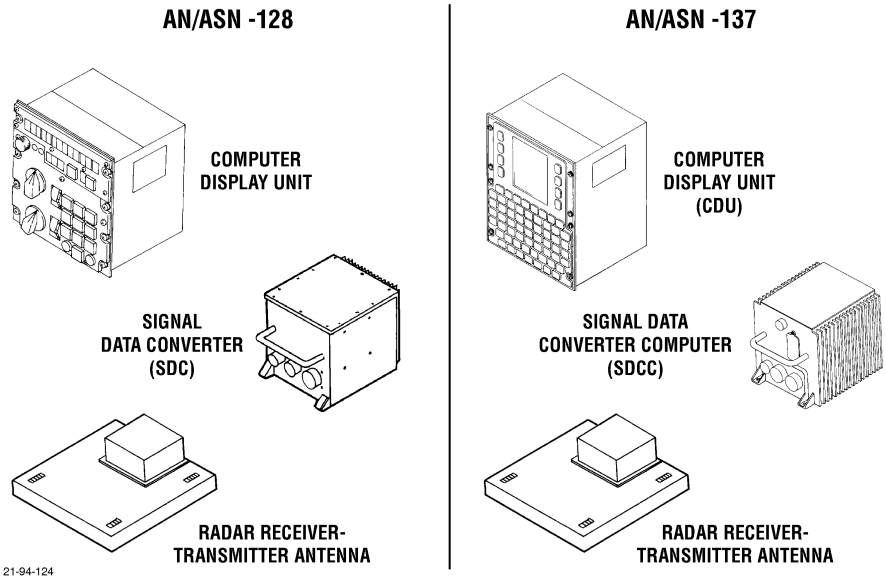
3. Short-term or instantaneous velocity information is not as accurate as the average velocity.

E. AH-64A lightweight doppler navigation systems

1. Aircraft with serial numbers up to 85-25488 have the AN/ASN-128 lightweight doppler navigation system (LDNS).

2. Aircraft with serial number 86-8940 and subsequent have the AN/ASN-137 LDNS.

LIGHTWEIGHT DOPPLER NAVIGATION SYSTEM (LDNS) AN/ASN-128 OR AN/ASN-137



NOTES

A. The LDNS is the primary navigation system for the AH-64A. By utilizing doppler principles, the LDNS computes present position, bearing, distance, and time for the destinations stored.

B. One of two different lightweight doppler navigation systems (LDNS) are installed on the AH-64A.

1. The AN/ASN-128 is installed in aircraft with tail numbers lower than 86-8940.

2. Aircraft with tail number 86-8940 and subsequent, have the AN/ASN-137 installed.

C. Capabilities of the (LDNS)

1. The LDNS is a dead-reckoning navigational device that continuously measures helicopter velocity in order to compute present position.

2. The LDNS is completely self-contained, requires no ground base aids, and provides accurate velocity measurements from ground levels to above 10,000 feet.

3. The LDNS provides

a. Distance, course, and time indications for the stored destinations.

b. Present position, or destination, either in latitude and longitude (degrees and minutes) or in universal transverse mercator (UTM) coordinates.

c. The LDNS provides visual display of:

(1) Ground speed in kilometers per hour

(2) Track angle in degrees

(3) Cross track distance in kilometers

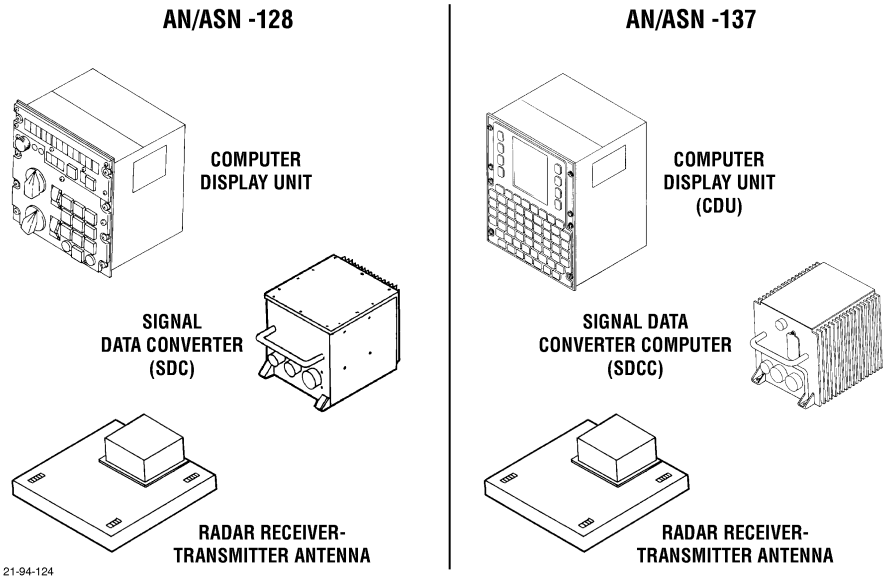
(4) Track angle error in degrees

(5) Distance to destination in kilometers

(6) Bearing to destination in degrees

(7) Time to destination in minutes

LIGHTWEIGHT DOPPLER NAVIGATION SYSTEM (LDNS) AN/ASN-128 OR AN/ASN-137



NOTES

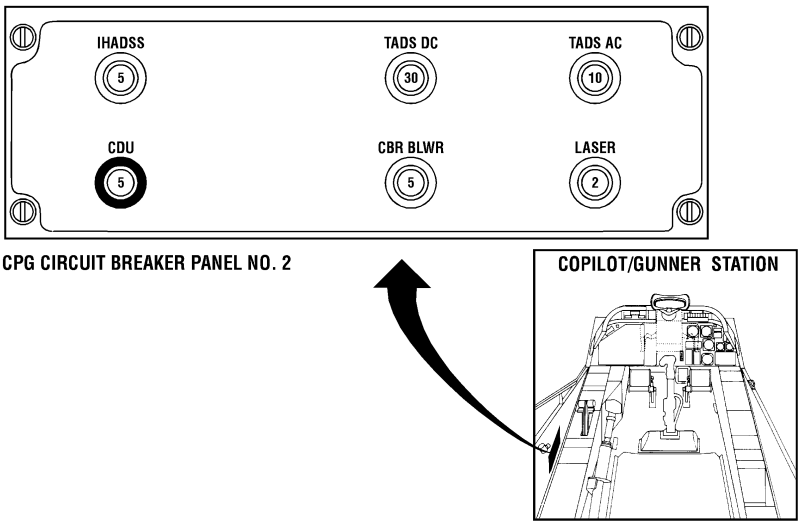
(8) Spheroid code of destination (entered manually)

Name	Code
Clarke 1866	CL6
Clarke 1880	CL0
International	IN0
Bessel	BE0
Everest	EV0
Australian National	AU0

(9) Magnetic variation of destination (entered manually)

071-6

CDU CIRCUIT BREAKER



NOTES

D. Components common to the AN/ASN-128 or /AN/ASN-137 LDNS systems

1. Circuit protection

a. CDU circuit breaker (AN/ASN-137 LDNS system only)

(1) Provides circuit protection for the CDU.

(2) The CDU circuit breaker is located on the CPG's no. 2 circuit breaker panel.

(3) The CDU circuit breaker is rated at 5 amps.

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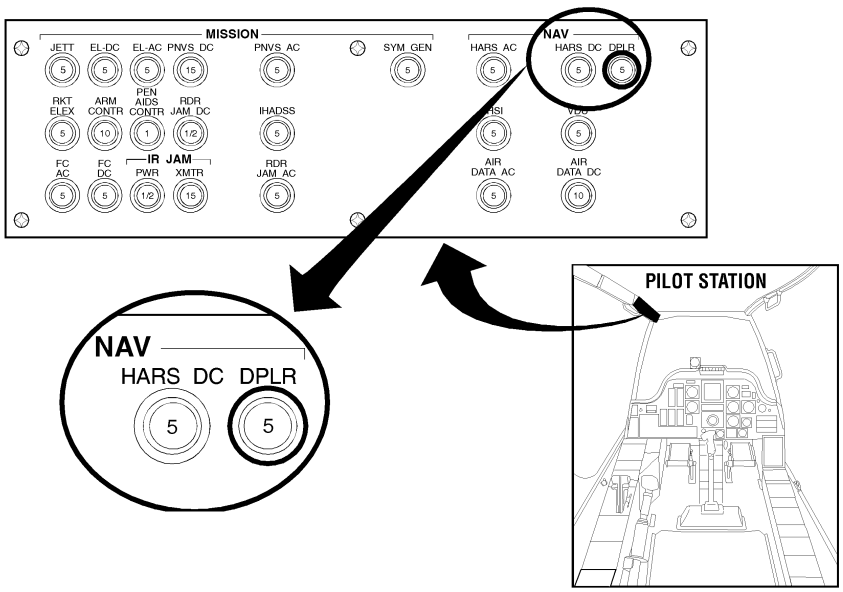
DOPPLER CIRCUIT BREAKER



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88-87

NOTES

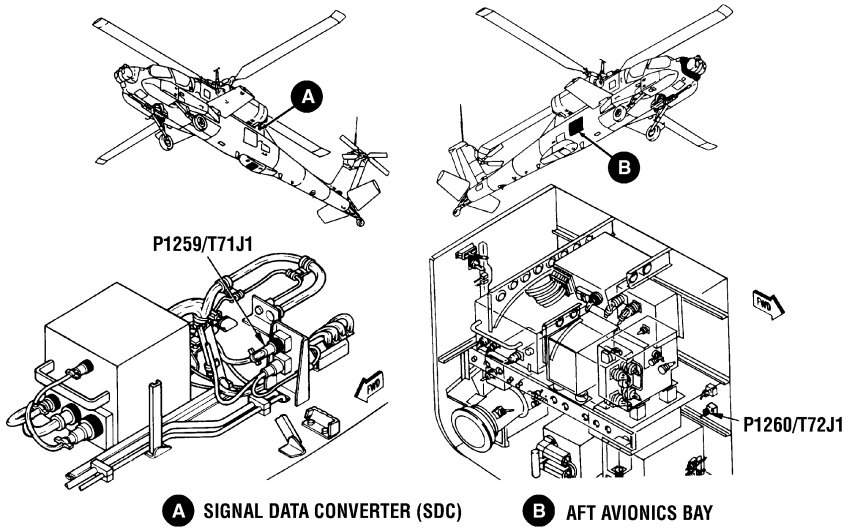
b. Doppler circuit breaker

(1) The purpose of the doppler circuit breaker is to provide circuit protection for the doppler system.

(2) The doppler circuit breaker is located on the pilot's forward circuit breaker panel.

(3) The doppler circuit breaker is rated at 5 amps.

DLTU LOCATION 1



A SIGNAL DATA CONVERTER (SDC)

B AFT AVIONICS BAY

21-93-04

NOTES

2. Data link terminal units

   a. Provides the electrical interface between the multiplex bus, the CDU, and the signal data converter computer SDC(C) .

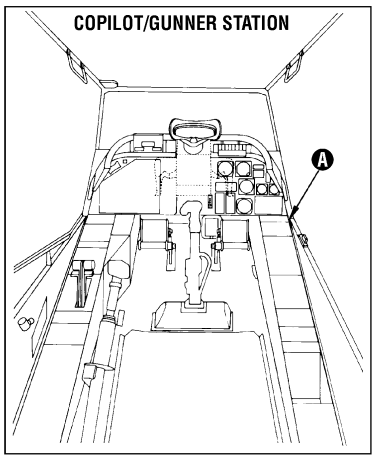
   b. Isolates the bus from the units in case of faults.

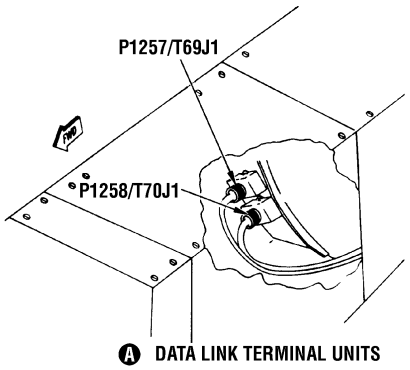
   c. Locations

      (1) T71 is located behind the SDC(C) on the left aft catwalk. It functions as the data link to the SDC(C) from the 1553 data bus number 1.

      (2) T72 is located in the aft avionics bay on the back wall. It functions as the data link to the SDC(C) from the 1553 data bus number 2.

DLTU LOCATION 2





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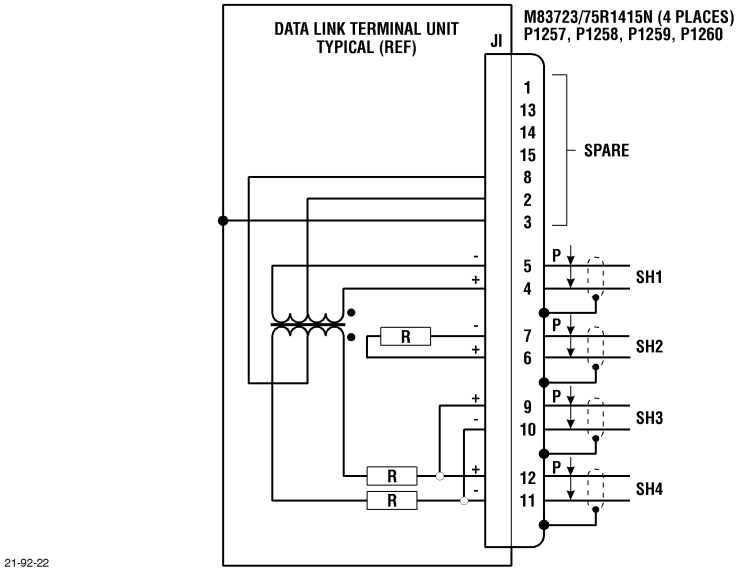
NOTES

(3) T69 and T70 are located in the CPG station in the forward right console beneath the CPG VHF radio. They function as the data links between the CDU and the data busses number 1 and 2 respectively.

071-6

DLTU SCHEMATIC



NOTES

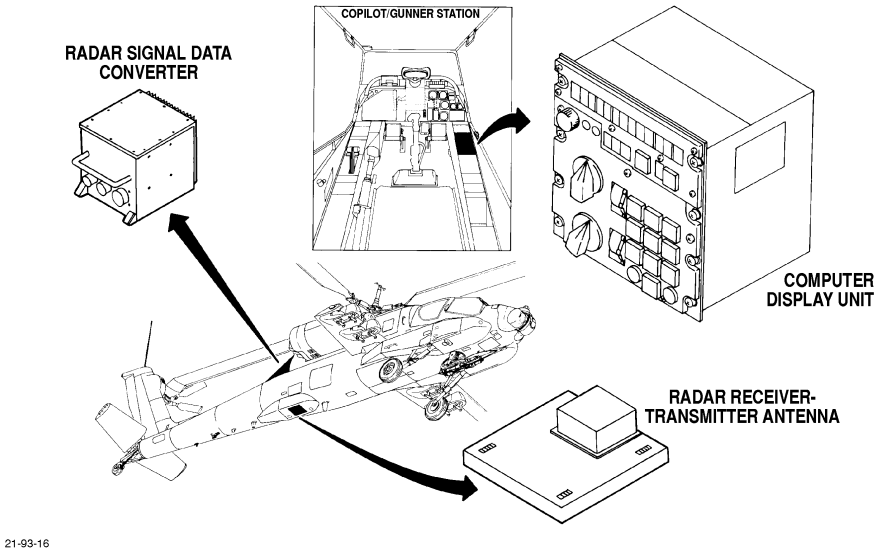
d. Description

(1) The DLTU harness on each end of the primary and secondary bus has a built-in termination resistor that terminates the bus in its characteristic impedance of 71 ohms.

(2) Each DLTU contains a 53-ohm resistor in series with each connection to the data bus. This provides a minimum of 106 ohms of resistance across the bus if the coupling transformer were to short out.

071-6

AN/ASN-128 LIGHTWEIGHT DOPPLER NAVIGATION SYSTEM (LDNS)



NOTES

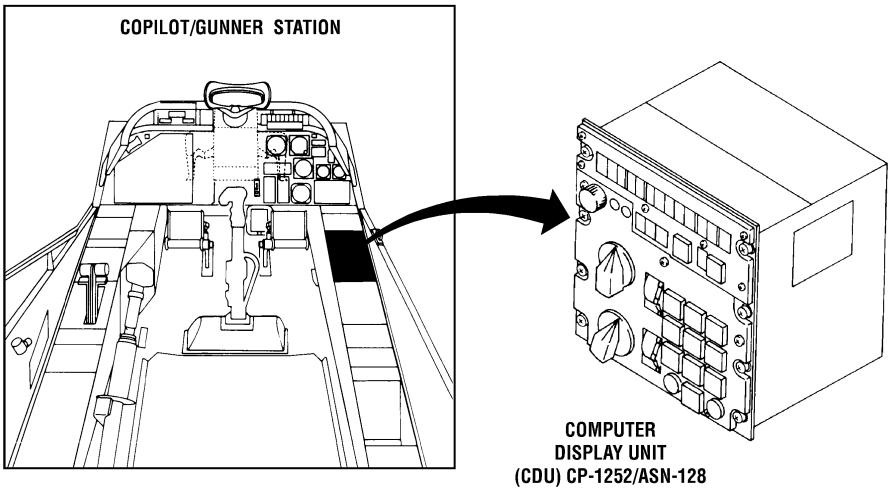
A. AN/ASN-128 major components

1. Computer Display Unit (CDU) CP-1252/ASN-128

2. Radar Receiver/Transmitter Antenna (RTA) RT-1193/ASN-128

3. Radar Signal Data Converter (SDC) CV-3338/ASN-128

COMPUTER DISPLAY UNIT LOCATION



NOTES

B. Component purpose, location, description and operation

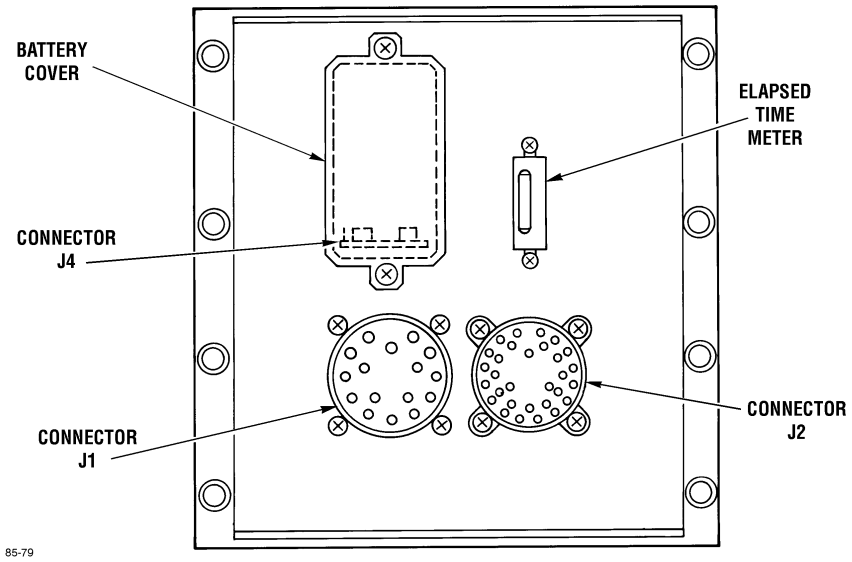
1. Computer display unit (CDU) CP-1252/ASN-128

a. Provides control, displays, and performs the navigation computations for the LDNS. It has the capability to store up to ten waypoints.

b. Converts the doppler signal into velocity information for use by the AH-64A fire control computer.

c. The CDU is mounted in the CPG's right console.

CDU REAR PANEL



NOTES

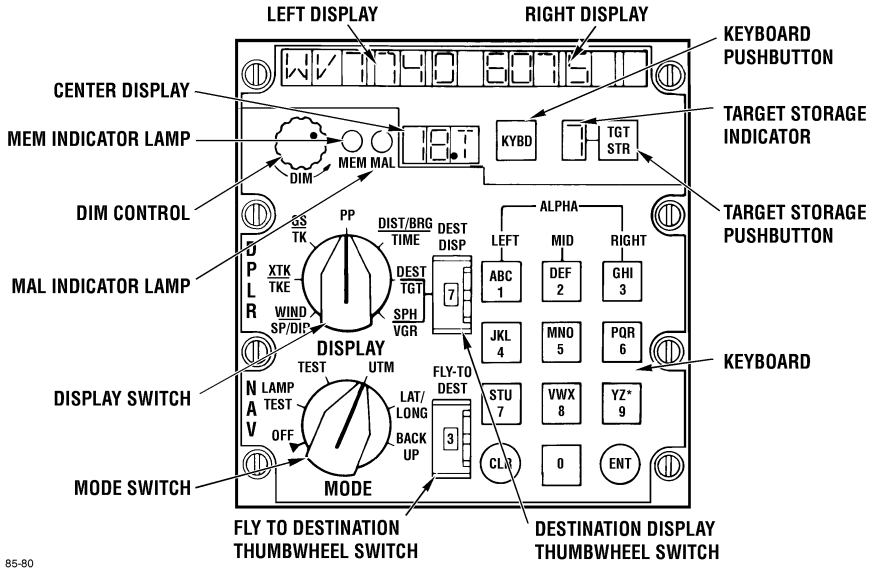
d. The CDU rear panel components and functions

(1) J1 and J2 - power and signal connectors

(2) Elapsed time meter - indicates the cumulative operating time of the CDU

(3) Battery cover - cover and snap-on terminal connector (J4) hold an 8.4 VDC battery which maintains computer memory (present position)

CDU CONTROLS AND INDICATORS



NOTES

e. The CDU front panel components and functions

(1) The MODE switch selects navigation set mode of operation.

(a) OFF - in this position the navigation set is inoperable; however, an internal battery maintains voltages on the RAM to retain stored data.

(b) LAMP TEST - checks operation of all lamps.

(c) TEST - initiates built-in-self test exercise for the navigation set.

(d) UTM - selects universal transverse mercator navigational mode of operation.

(e) LAT/LONG - selects latitude/longitude navigational mode of operation.

(f) BACKUP - places navigation set in remembered velocity mode of operation.

(2) DISPLAY switch - selects navigation data for display.

(3) MAL indicator lamp - lights when a navigation set malfunction is detected by the built-in test circuitry.

(4) DIM control - controls light intensity of the display characters and the KYBD push buttons.

(5) MEM indicator lamp - lights when the radar portion of the navigation set is in a non-track condition.

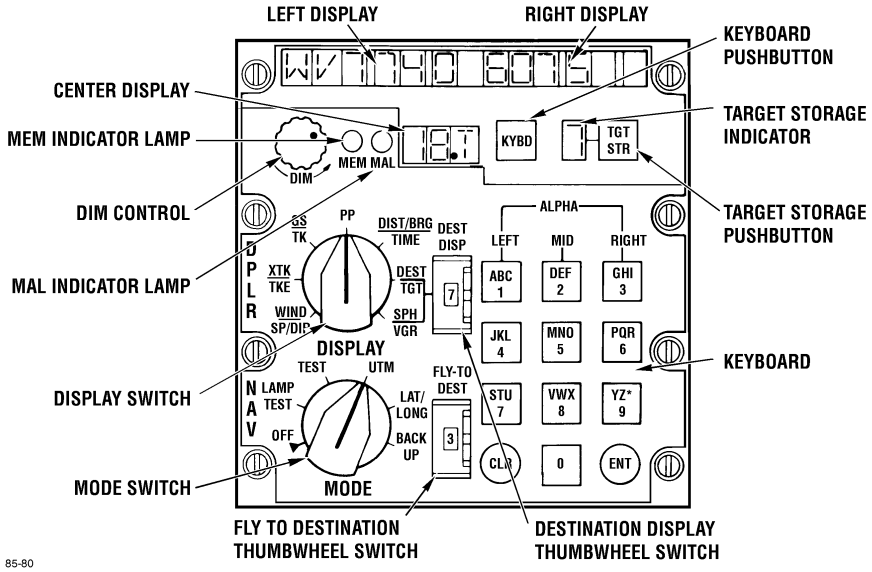
(6) Center, left, and right display lamps - light to provide the data, in alphanumeric and numeric characters, as determined by the setting of the DISPLAY switch, the MODE switch, and operation of the keyboard.

(7) KYBD pushbutton - used in conjunction with the keyboard to allow data entry into the computer.

(8) TGT STR indicator - displays the destination number (memory location) in which present position is stored when the TGT STR pushbutton is pressed.

(9) TGT STR pushbutton - stores present position data when pressed.

CDU CONTROLS AND INDICATORS



NOTES

(10) Keyboard - used to set up data for entry into memory.

(a) ENT key - enters displayed data into memory after keyboard inputs have been made.

(b) CLR key - clears last entered character when pressed once. When pressed twice, clears entire display panel under keyboard control.

(11) DEST DISP thumb wheel switch - the destination display thumb wheel switch is used in conjunction with the DEST/TGT/and SPH/VAR positions of the DISPLAY switch to select the destination whose coordinates or magnetic variation are to be displayed or entered.

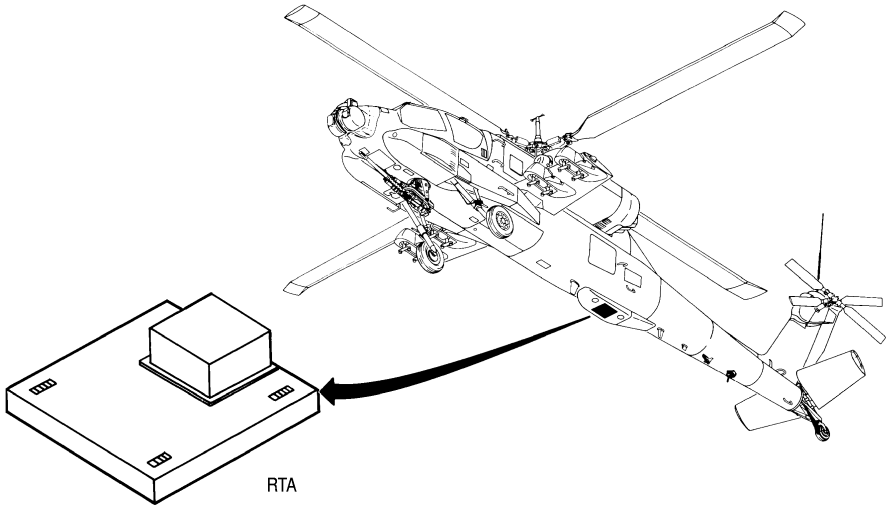
(12) FLY-TO-DEST thumb wheel switch - the fly-to-destination thumb wheel switch selects the destination to which XTK/TKE and DIST/BRG/TIME are displayed when the DISPLAY switch is set to either of these positions.

f. Operation - when the DISPLAY switch is set to the DEST/TGT or SPH/VAR position and the KYBD pushbutton is pressed, data may be entered.

(1) To enter a number, press corresponding key or keys (1 through 0).

(2) To enter a letter, first press the key containing the desired letter (A through Z) (or asterisk), then press a key in the left, middle, or right columns (depending on whether the desired letter is on the left, middle, or right of the key).

RTA LOCATION



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NOTES

2. Receiver/transmitter antenna (RTA) RT-1193/ASN-128

   a. The RTA generates microwave energy, transmits the energy to the earth's surface, and receives the reflected energy from the surface.

   b. The RTA is mounted to the RTA support structure on the bottom center of the fuselage. The structure is precision aligned by a laser boresight process. Any damage or maintenance actions that remove the RTA support structure necessitate that the support structure be realigned. An antenna drip lip is added to the doppler structure to prevent leaking fluids from contaminating the antenna.

   c. When operating power from the mode switch is applied, the RTA:

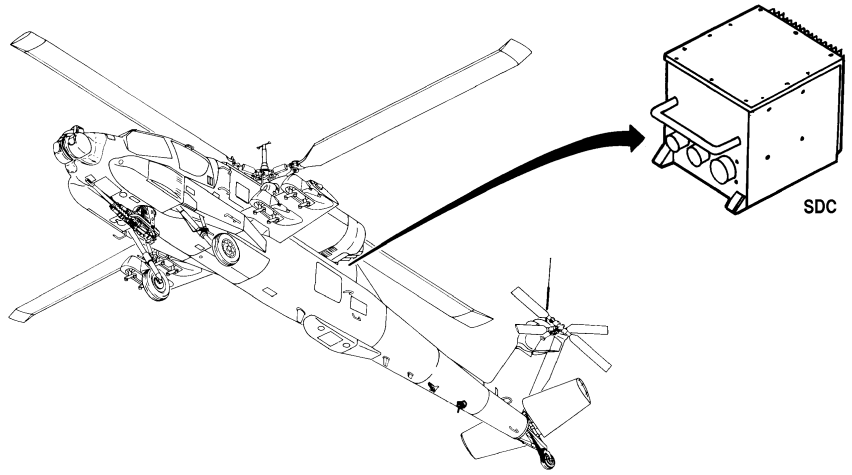
      (1) Generates the 13.325 GHZ RF carrier frequency.

      (2) Utilizes the FM 30 KHZ to modulate the 13.325 GHZ RF carrier.

      (3) Utilizes the SDC beam switching signal to control the modulated RF carrier frequency.

      (4) Transmits the switched, modulated RF carrier frequency, then receives the doppler shifted RF signal to develop the demodulated doppler signal for use by the SDC.

SDC LOCATION



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NOTES

3. Radar signal data converter (SDC) CV-3338/ASN-128

a. The SDC provides the RTA with:

(1) Power supply voltages

(a) " 15 VDC

(b) + 5 VDC

(2) Beam switching signal (controls which beam-pairs transmit).

(3) Test signal

(4) FM 30 KHZ

b. Utilizes the RTA signals

(1) Doppler signal

(2) Antenna calibration constant

c. Utilizes the CDU signals.

(1) On off control signal

(2) Test signal

d. The SDC provides the CDU with:

(1) Power supply voltages

(a) " 15 VDC

(b) + 5 VDC

(2) Filtering and frequency tracking of the doppler signal

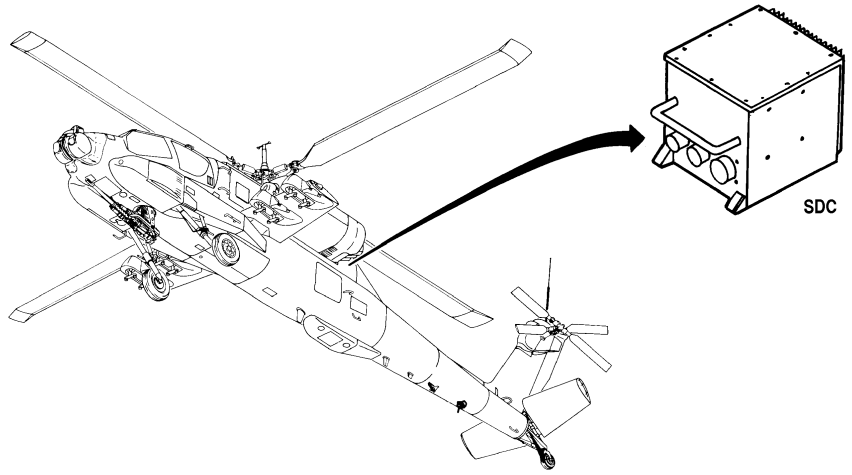
(3) The SDC combines the doppler velocity information with HARS inputs and provides data in a usable format for the CDU. It converts the following analog signals.

(a) The four doppler beam velocities

(b) Magnetic heading

(c) Pitch and roll

SDC LOCATION



21-93-02

NOTES

(4) Antenna calibration constants.

(5) Status.

e. The HARS provides the SDC with:

(1) Magnetic heading

(2) Pitch and roll

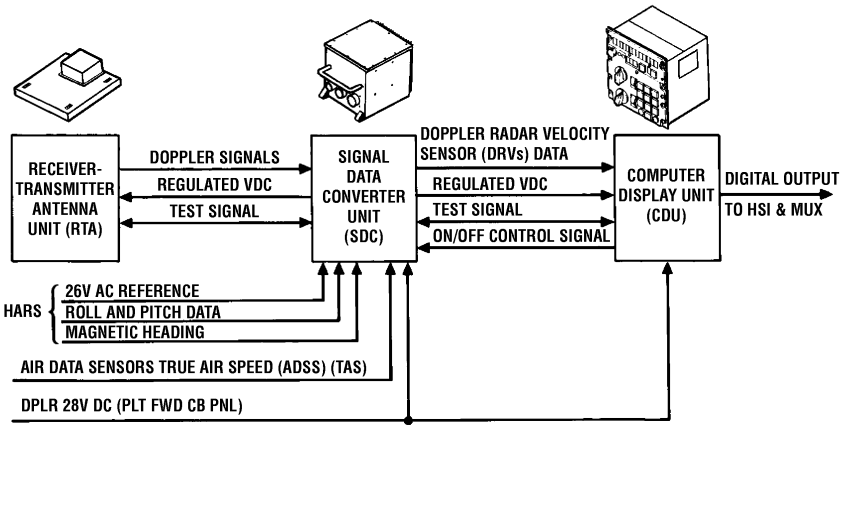
(3) 26 VAC reference signal

f. The SDC is mounted on the aft transmission deck, left of the catwalk.

g. The SDC is a solid state line replaceable unit that contains electronic circuit cards and power supplies.

h. The SDC and RTA make up the doppler radar velocity sensor (DRVS). The DRVS data is applied to the CDU for navigational computations. These computations are displayed on the left, right, and center displays.

LDNS BLOCK DIAGRAM



85-83

NOTES

C. Block diagram discussion

1. Power inputs - 28 VDC primary power is supplied to the SDC and CDU via the doppler circuit breaker located on the pilot forward CB panel.

2. HARS external inputs - pitch and roll data, magnetic heading, and 26 VAC reference is supplied to the SDC from the HARS.

3. BITE - the CDU is checked on a continuous basis by use of Built-In-Test-Equipment (BITE).

   a. When the CDU MODE switch is set to TEST, the SDC transmits test velocities, test signals, and test calibration constants.

   b. The BITE logic compares these signals to stored constants to determine the operating status.

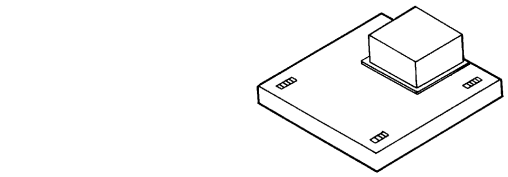
   c. If a failure has occurred, the BITE logic develops the proper failure code for display on the front panel.

4. Backup mode - the backup mode is entered automatically when the CDU determines that the doppler velocity is invalid.

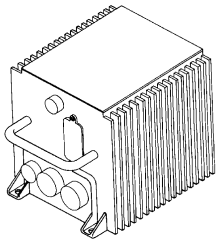
   a. The CDU goes into memory, as indicated by the MEM lamp on the front panel.

   b. The backup mode can also be selected manually by the selection of BACKUP on the CDU MODE switch.

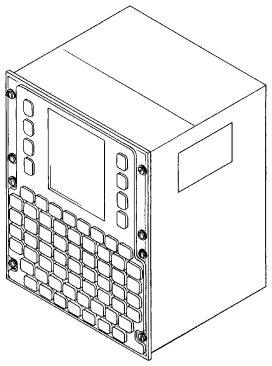
AN/ASN-137 LIGHTWEIGHT DOPPLER NAVIGATION SYSTEM



RADAR RECEIVER-
TRANSMITTER ANTENNA



SIGNAL DATA
CONVERTER COMPUTER
(SDCC)



COMPUTER
DISPLAY UNIT
(CDU)

21-93-20

NOTES

A. AN/ASN-137 LDNS features

1. The functions of the AN/ASN-137 LDNS are the same as those of the AN/ASN-128 except that 20 destinations may be stored.

2. The operating procedures differ due to the installation of a new computer display unit (CDU).

B. The AN/ASN-137 LDNS major components

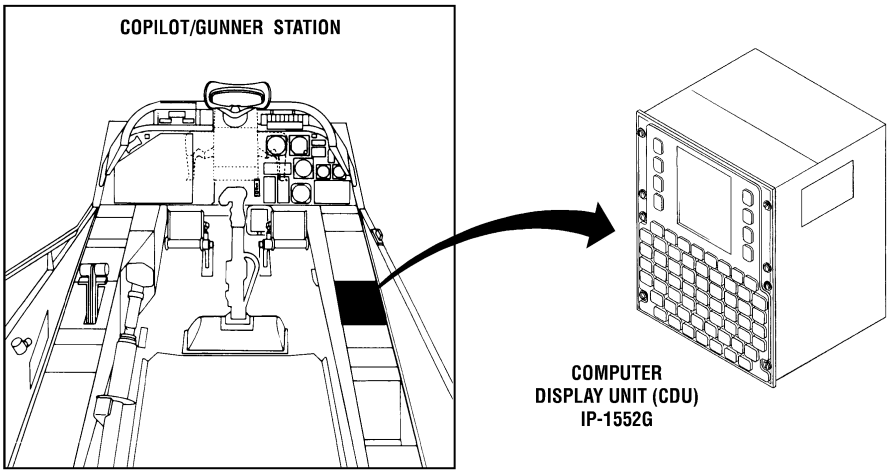
1. Computer display unit (CDU) IP-1552G

2. Radar receiver/transmitter antenna (RTA) RT-1193/ASN-128

3. Radar signal data converter (SDC) CV-3669/ASN-137

C. Component purpose, location, description and operation

COMPUTER DISPLAY UNIT LOCATION IP-1552G



NOTES

1. Computer display unit (CDU) IP-1552G

   a. The CDU is located in the CPG's right console.

   b. The CDU performs the following functions.

      (1) The CDU is the CPG's interface with the DNS.

      (2) The CDU provides the DNS display.

      (3) The CDU functions as the bus controller for the DNS. The AN/ASN 137 doppler uses a redundant MIL-STD-1553B multiplex bus for communication between the SDCC and the CDU. This bus is completely removed and independent from the multiplex bus currently associated with the AH-64A.

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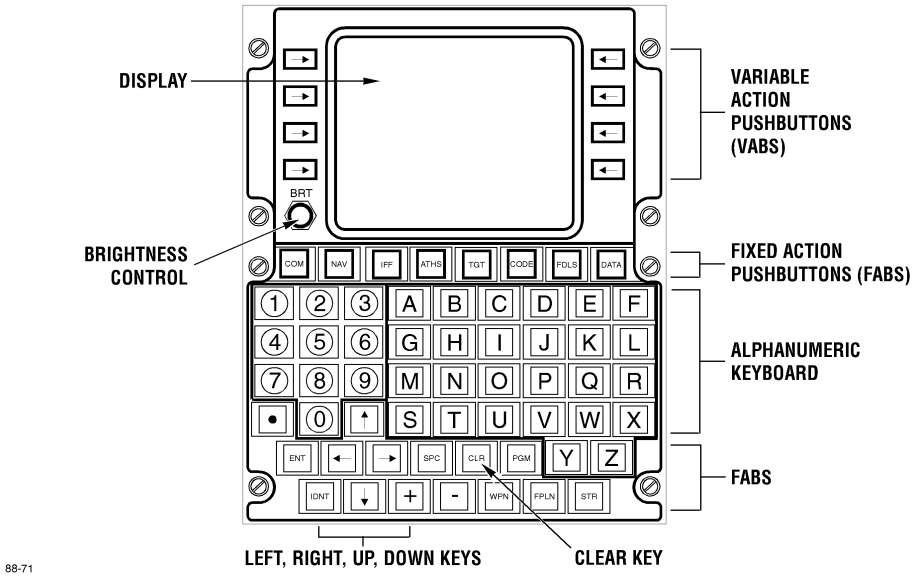
COMPUTER DISPLAY UNIT (CDU)
IP-1552G



NOTES

c. The CDU has an alphanumeric keyboard used for entering data on the CDU display. The keyboard has thirteen Fixed Action Buttons (FAB) of which four are functional with the current software.

d. The CDU display is formatted into organized pages, each page consists of eight lines.

(1) The top seven lines (22 characters) are used for displaying navigation data or indicating functions selectable from that page.

(2) The eighth line (21 characters) is designated as the scratchpad line. It is used for entering and editing data using the keyboard.

e. There are eight variable action buttons (VAB) arrayed four on each side of the CDU display. Each VAB performs a particular function depending on which page is displayed on the CDU. A VAB may be used to transfer data from the scratchpad to a displayed caption or to select another page to perform other functions.

f. The front panel displays and controls

(1) Display screen - the display formats are organized as pages, a page consists of eight lines. The top seven lines display data and the eighth line is used as a scratchpad for entering and editing data.

(2) Keyboard keys - alphanumeric keyboard is used for entering data into the scratchpad (8th line of CDU display).

(3) Left and right arrow keys - moves the cursor one space in the respective direction per keystroke. When pressed constantly, moves the cursor at a 4 Hz rate.

(4) Up and down keys - scrolls through waypoint dictionary pages one page per keystroke. When constantly pressed, scrolls through all dictionary pages at a 1 Hz rate.

(5) Variable action buttons (VAB) - refers to the eight vertical line select push buttons which are used for addressing data entry.

(6) BRT control - controls light intensity of the display screen.

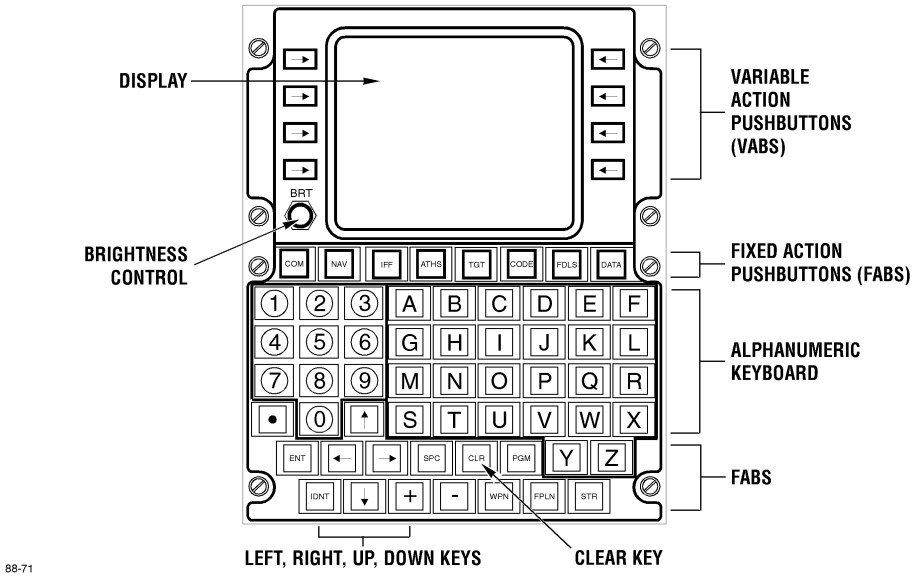
(7) NAV pushbutton - utilized to access the NAV top level page. Pressing the NAV FAB overrides other displays and returns the CDU to the NAV top level present position page.

(8) FDLS pushbutton - used to access the FDLS page. DNS FDLS test is initiated from this page.

(9) COM pushbutton - not active

071-6

COMPUTER DISPLAY UNIT (CDU)
IP-1552G



NOTES

(10) IFF pushbutton - not active

(11) ATHS pushbutton - not active

(12) TGT pushbutton - not active

(13) CODE - not active

(14) DATA - not active

(15) CLR pushbutton - clears the entire scratchpad of characters. Freezes erroneous character string in the scratchpad during validity check by the CDU. The cursor is positioned under the first erroneous character detected by the CDU.

(16) ENT pushbutton - not active

(17) SPC pushbutton - enters a blank space character

(18) PGM pushbutton - not active

(19) IDNT pushbutton - not active

(20) WPN pushbutton - not used

(21) FLPN pushbutton - displays the first of 7 waypoint dictionary pages. Dictionary pages may then be scrolled using up/down arrow keys.

(22) STR - utilized to enter instantaneous target waypoint coordinates into the CDU.

CDU MODES OF OPERATION

- NAVIGATION MODE
- BACKUP MODE
- HOVER BIAS CALIBRATION MODE
- TEST MODES
  - CONTINUOUS
  - ON COMMAND

88-72

NOTES

g. Modes of operation

(1) There are four modes of operation for the AN/ASN-137.

(a) Navigation mode

(b) Backup mode

(c) Hover Bias Calibration Mode (HBCM)

(d) Test (on command and continuous) mode

(2) When electrical power is first applied to the helicopter, the CDU is powered and the NAV top level page is displayed. The DNS is not powered at this time.

(3) Navigation mode - this is the initial powerup mode of the DNS. In the navigation mode, power is applied to all DNS components. Computed present position data is derived by the DNS computer from doppler radar data. This is the most accurate navigation mode.

(4) Backup mode

(a) The backup mode is manually selected by the CPG.

(b) Backup mode is usually selected because DNS FDLS has detected a failure of the doppler receiver/transmitter antenna.

(c) In this mode the DNS computer uses the last valid doppler radar ground speed for navigation calculations.

1) The doppler radar velocities are not available.

2) The HARS goes into FREE INERTIA when the DNS is in the backup mode.

(d) The CPG can change the ground speed used by entering his computed or best estimation of ground speed on the NAV top level page.

(e) Ground speed can only be entered by the CPG when the DNS is in backup mode.

CDU MODES OF OPERATION

- NAVIGATION MODE
- BACKUP MODE
- HOVER BIAS CALIBRATION MODE
- TEST MODES
  - CONTINUOUS
  - ON COMMAND

88-72

NOTES

(5) Hover bias calibration mode (HBCM)

(a) The HBCM calibrates the DNS system for small velocity errors that may be present in the doppler receiver/transmitter subsystem. The velocity bias corrections are computed by the DNS computer and are applied to all subsequent doppler radar velocities.

(b) The velocity bias (error), when present, is noticeable when the helicopter is at a hover or slow speeds.

(c) When HBCM is selected, the CPG can manually start and stop the calibration. If a calibration NO-GO status is displayed at the conclusion, a re-calibration may be restarted by the CPG. If a GO calibration is computed, the bias velocities are automatically stored and applied continuously to all subsequent navigation computations.

(6) Test modes - the DNS and CDU subsystems include a continuous test function and an on command (FDLS) test function.

(a) Continuous test

1) Continuous test is a wraparound check of the receiver/transmitter antenna, the signal data converter computer, and the CDU performance.

2) This test mode provides for monitoring of DNS status via transmit messages, provision is made for continuous CDU monitoring of the DNS/CDU 1553B dedicated bus communications integrity.

3) If a DNS failure is detected by the CDU, the CDU screen displays FDLS message on the NAV top level page. System status can be displayed by use of the FDLS FAB.

(b) On command test (operator initiated)

1) When the on command test is initialized, the CDU screen displays NAV SYS TEST IN PROG until the test is completed.

2) DNS test status transmit message is then displayed on the CDU screen.

3) If no failures are detected, the CDU screen displays CDU/DNS GO and END OF LIST.

CDU MODES OF OPERATION

- NAVIGATION MODE
- BACKUP MODE
- HOVER BIAS CALIBRATION MODE
- TEST MODES
  - CONTINUOUS
  - ON COMMAND

88-72

NOTES

4) The CDU then calculates and displays heading, pitch, and roll in degrees from data provided by the DNS.

h. Displays

(1) General information

(a) The CDU screen display format is organized into pages. Each page consists of eight lines. The top seven lines are 22 characters for displaying data and the eighth line (scratchpad) consists of 21 characters for editing data.

(b) Pages may contain navigational data or error messages.

CDU SCREEN DISPLAYS

- NAV TOP LEVEL PAGE
- ADMIN PAGE
- HOVER BIAS CALIBRATION MODE PAGE
- FDLS PAGE
- FLIGHT PLAN DICTIONARY PAGES

88-73

NOTES

(c) CDU screen displays

1) NAV top level, present position page

2) ADMIN page

3) Hover bias calibration mode page

4) FDLS page

5) Flight plan dictionary page

(d) Screen displays may be updated by automatic navigational computations of the DNS, error messages, or manual operator entries into the scratchpad (8th line of CDU display).

(e) Switching between modes of operation or implementing functions is accomplished by using a combination of dedicated FABs and VABs.

(2) Display timeout rules

(a) 30 second timeout

1) The CDU reverts to the NAV top level page automatically from the ADMIN or any of the FPLN (waypoint dictionary) pages after 30 seconds if there are no characters in the scratchpad.

2) The 30 second timer is reset each time a FPLN page is scrolled with the up/down arrow when the scratchpad contains no data.

(b) Three second timeout - the CDU reverts to the NAV top level page automatically from the ADMIN page 3 seconds after pressing any of the following VABs.

1) PWR ON or PWR OFF

2) BACKUP

3) MODE UTM or MODE L/L

4) DSPL KPH or DSPL KTS

CDU SCREEN DISPLAYS

- NAV TOP LEVEL PAGE
- ADMIN PAGE
- HOVER BIAS CALIBRATION MODE PAGE
- FDLS PAGE
- FLIGHT PLAN DICTIONARY PAGES

88-73

NOTES

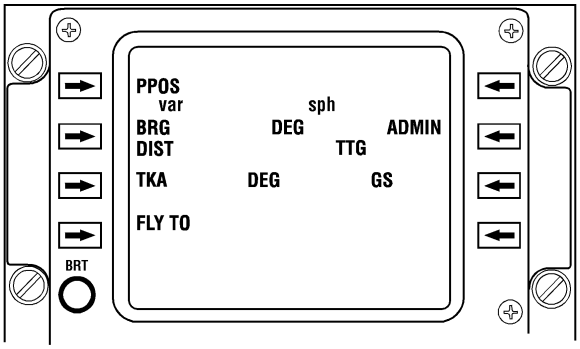
(c) Timeout exceptions

1) When HBCM entry is made from the ADMIN page, there is no timeout.

2) When the FDLS page is displayed, there is no timeout.

071-6

NAV TOP LEVEL PAGE - PWR OFF



88-74

NOTES

(3) NAV top level page

(a) The NAV top level page is displayed approximately 30 seconds after electrical power is applied.

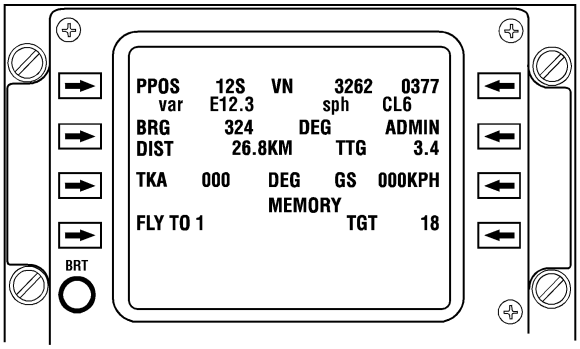
(b) No data is displayed until the DNS power is turned on.

(c) The DNS is powered by pressing the ADMIN VAB and then pressing the PWR OFF VAB on the ADMIN page.

(d) The DNS indicates a failure if it is powered and the HARS is off, or in the first 90 seconds of alignment.

071-6

NAV TOP LEVEL PAGE - PWR ON



88-75

NOTES

(e) When the DNS is powered up, the NAV top level page is displayed.

1) Line 1

a) PPOS represents the current DNS computed present position in either UTM or LAT/LONG.

b) The PPOS data may be changed or edited.

2) Line 2

a) Variation (VAR) and Spheroid (SPH) are the magnetic variation and spheroid associated with the PPOS.

b) VAR and SPH may be changed or edited.

3) Line 3

a) BRG is the direct bearing to the destination specified in the FLY TO position on line 7.

b) ADMIN is a VAB label that selects the page for various administrative functions associated with the DNS.

4) Line 4

a) TTG is the time-to-go (at current ground speed) to the destination specified in the FLY TO position.

b) DIST is displayed in either kilometers or nautical miles, independent of the PPOS data, as selected on the ADMIN page.

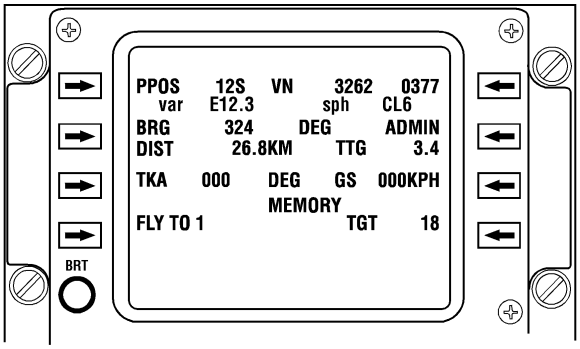
5) Line 5

a) TKA and GS are the computed track angle and ground speed.

b) Ground speed may be displayed in either kilometers per hour (KPH) or knots as selected on the ADMIN page.

071-6

NAV TOP LEVEL PAGE - PWR ON



88-75

NOTES

6) Line 6

a) This is the CDU and DNS status line. The line may be blank or display MEMORY, BACKUP, or FDLS.

b) Displays

1) MEMORY - a display on this line indicates that the DNS has lost a radar lock.

2) BACKUP - a display on this line indicates that the CPG has manually selected BACKUP.

3) FDLS - a display on this line indicates that the continuous FDLS test has detected a fault in the CDU/DNS system.

7) Line 7

a) FLY TO shows the selected destination to which the DNS is navigating. The displayed value can be any of the 20 locations entered in the FPLN dictionary.

b) The operator can select flightplan dictionary pages by pressing the FPLN FAB.

c) The first page displayed is determined by the FLY TO selection on the NAV top level page. The up and down arrow keys are used to scroll to the other pages.

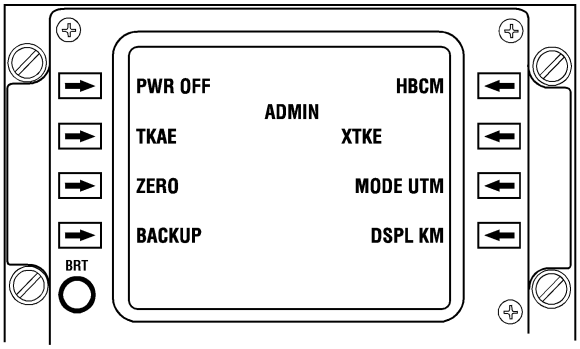
d) TGT displays the storage location that is used when the STR FAB is pressed.

Memory locations 16 through 19 are used repetitively.

8) Line 8 - this is the scratchpad line for data entry.

071-6

ADMIN PAGE



21-92-08

NOTES

(4) ADMIN page

(a) The ADMIN page is used to select other modes of DNS operation and display functions.

(b) ADMIN page display

1) Line 1

a) PWR OFF or PWR ON is an alternate action VAB powering the DNS.

b) HBCM selects the hover bias calibration mode page.

2) Line 2 - identifies the ADMIN page.

3) Line 3

a) TKAE is a data display only showing the track angle error. The L or R character specifies which direction to steer to reduce the TKAE to zero.

b) XTKE data is displayed only when DNS power is on. It specifies the distance cross track in KM.

4) Line 4 - blank

5) Line 5

a) ZERO is a function which permits zeroizing the CDU or DNS memory.

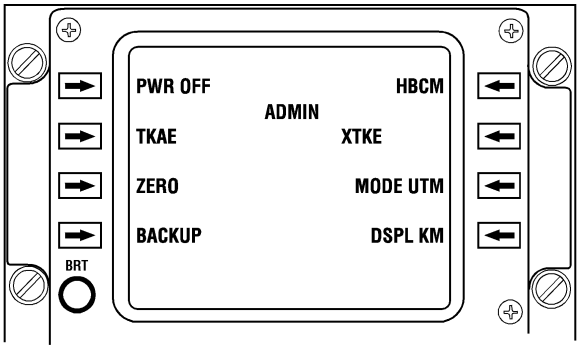
b) The specific system to zero is accomplished by entering either CDU or DNS in the scratchpad and pressing the ZERO VAB.

c) Zeroizing the CDU clears all FPLN dictionary storage locations.

d) Zeroizing the DNS causes loss of HBCM data.

071-6

ADMIN PAGE



21-92-08

NOT ES

e) MODE L/L or MODE UTM is an alternate action VAB selecting the coordinate system for display and data entry of coordinate data.

6) Line 6 - blank

7) Line 7

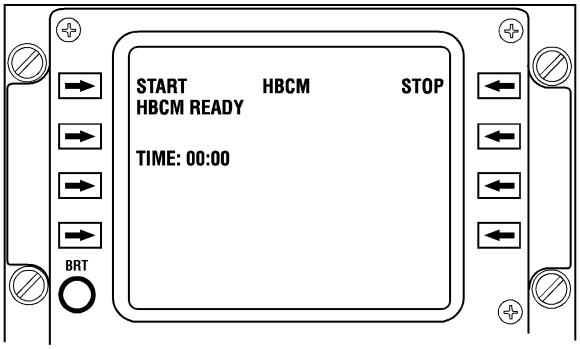
a) BACKUP ON or BACKUP OFF is an alternate action VAB selecting DNS BACKUP mode.

b) DISPL KM or DISPL NM is an alternate action VAB that permits the switching of DIST and GS only from KM/KPH to NM/KTS and back.

8) Line 8 - this is the scratchpad line for data entry.

071-6

HBCM PAGE



88-77

NOTES

(5) HBCM page

(a) The HBCM page is used to START and STOP the bias calibration of the DNS.

(b) The 30-second automatic reversion to NAV top level page is disabled when HBCM is selected.

(c) HBCM page display

1) Line 1

a) START is used to activate the HBCM calibration.

b) STOP is used to terminate calibration.

2) Line 2

a) HBCM READY indicates the DNS is ready to start the calibration sequence.

b) HBCM ACTIVE, HBCM GO, and HBCM NO-GO are also displayed on the line as appropriate.

3) Lines 3 and 4 - error messages pertinent to an HBCM NO-GO condition are displayed on this line. Possible DNS error messages are:

a) TIME BELOW 2 MIN

b) TIME EXCEEDED 8.2 MIN

c) BIAS EXCEEDS 0.3 KTS

d) EXCESSIVE MEM CONDITION

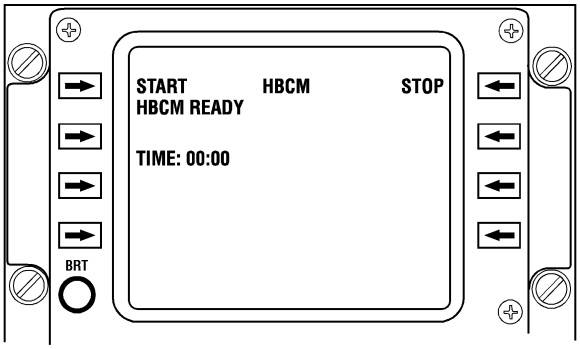
4) Line 5

a) Time XX:XX indicates elapsed time in minutes/seconds for DNS computations of the bias calibration.

b) The timer stops while the DNS is in memory during the bias calibration.

071-6

HBCM PAGE



88-77

NOTES

5) Line 6 - blank

6) Line 7 - blank

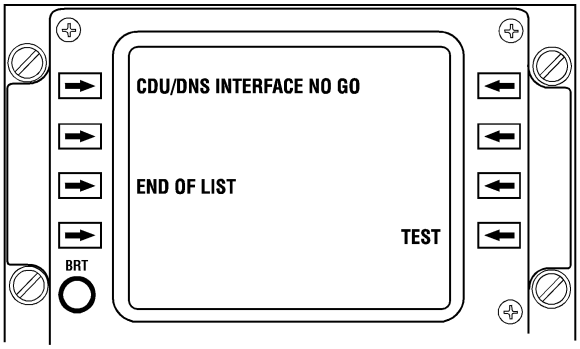
7) Line 8 - the scratchpad is not used on the HBCM page.

(6) FDLS page

(a) Continuous test mode

1) This is a wraparound check of the DNS and if a failure exists, a FDLS message is displayed on line 6 of the NAV top level page.

CONTINUOUS TEST MODE



88-78

NOTES

2) The FDLS FAB is utilized to select the FDLS page which displays messages if the continuous test mode fails.

071-6

CONTINUOUS TEST MODE MESSAGES

- DNS RAM ERASED
- PROG PLUG NOT CONNECTED
- PROG PLUG NOT PROPERLY PROGRAMMED
- RTA NOT CONNECTED
- DNS IN REMEMBERED VEL
- GS/TKA ENTRY ENABLED
- CDU/DNS INTERFACE NO GO

88-79

NOTES

a) DNS RAM ERASED

b) PROG PLUG NOT CONNECTED

c) PROG PLUG NOT PROPERLY PROGRAMMED

d) RTA NOT CONNECTED

e) DNS IN REMEMBERED VEL

f) GS/TKA ENTRY ENABLED

g) CDU/DNS INTERFACE NO GO

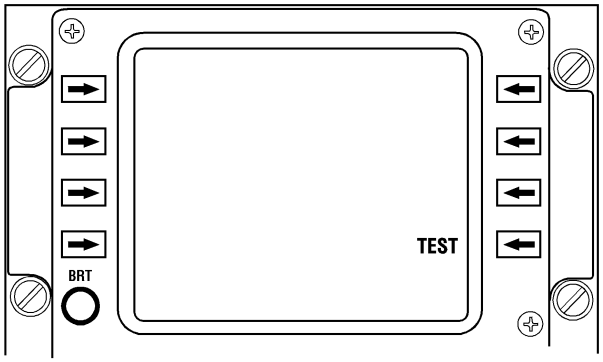
3) An END OF LIST message is displayed following the last message. If there are more than three malfunctions detected, the up and down arrow keys scroll through the display pages.

(b) On command test

1) The FDLS page is used to initiate the on command FDLS test function.

2) The FDLS page is selected by pressing the FDLS FAB.

FDLS PAGE



88-70

NOTES

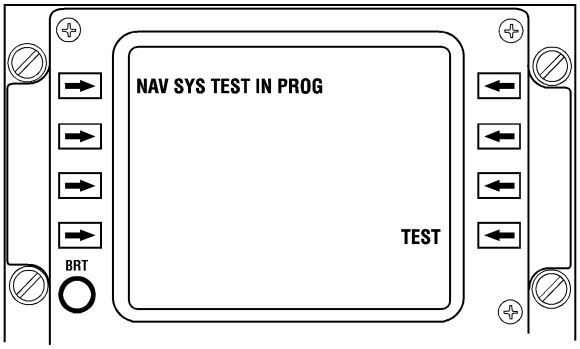
3) FDLS page display

a) Lines 1 through 6 - blank

b) Line 7 - TEST initiates the on command FDLS test for the CDU and DNS. When the test is initiated, a NAV SYS TEST IN PROG message is displayed.

071-6

ON COMMAND TEST



88-81

NOTES

c) Line 8 - scratchpad is not used in FDLS and is cleared when the FDLS page is selected.

4) The GO/NO-GO self test is comprised of the following internal tests.

a) PROM checksum verification

b) RAM read/write test

c) Limited non-volatile memory retention check

d) Display hardware BIT

e) 1553B terminal BIT

071-6

ON COMMAND TEST MESSAGES

- PITCH/ROLL FAIL
- HDG OR AC REF FAIL
- SDCC PS FAIL
- CPU/MEM FAIL
- SDCC WRAPAROUND
- A/D FAIL
- 1553 I/O FAIL
- SDC FAIL
- RTA FAIL
- SDCC CMD FAIL

88-82

NOTES

5) Possible NO-GO messages

   a) PITCH/ROLL FAIL

   b) HDG or AC REF FAIL

   c) SDCC PS FAIL

   d) CPU/MEM FAIL

   e) SDCC WRAPAROUND

   f) A/D FAIL

   g) 1553 I/O FAIL

   h) SDC FAIL

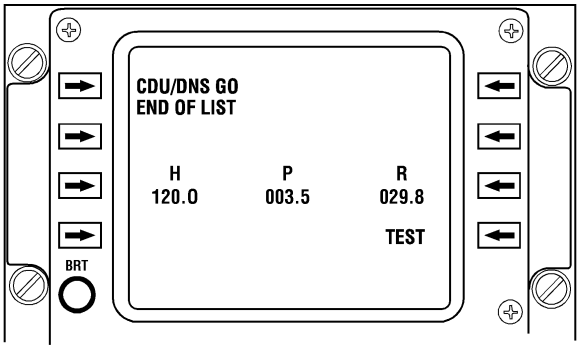
   i) RTA FAIL

   j) SDCC CMD FAIL

6) An END OF LIST message is displayed following the last message. If there are more than three malfunctions detected, the up and down arrow keys scroll through the display pages.

071-6

ON COMMAND TEST - GO



21-94-125

NOTES

7) If no failures are detected, the CDU calculates and displays the heading, pitch, and roll values.

071-6

FLIGHT PLAN DICTIONARY PAGES

PAGE	WAYPOINTS
1	HOME, 1, AND 2
2	3, 4, AND 5
3	6, 7, AND 8
4	9, 10, AND 11
5	12, 13, AND 14
6	15, 16, AND 17
7	18 AND 19

88-84

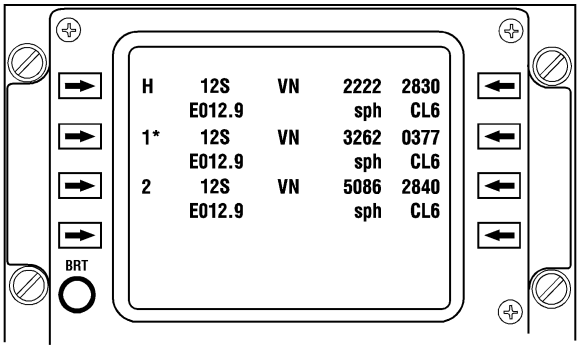
NOTES

(7) Flightplan dictionary pages (FPLN)

(a) The flightplan dictionary pages can be accessed by pressing the FPLN FAB.

(b) These pages are used to enter waypoint coordinate data into the scratchpad. Up to 20 waypoints can be entered.

FLIGHT PLAN DICTIONARY PAGE 1



88-85

NOTES

(c) FPLN page display

1) Line 1 - displays the Present Position (PPOS) coordinates of home base.

2) Line 2 - displays the magnetic Variation (VAR) and Spheroid (SPH) values of home base.

3) Line 3

a) Displays the PPOS of waypoint 1.

b) The * indicates the waypoint is the next FLY TO destination selected via the NAV top level page.

c) When the FPLN FAB is pressed, the flightplan dictionary page with the * is displayed.

4) Line 4 - displays the VAR and SPH of waypoint 1.

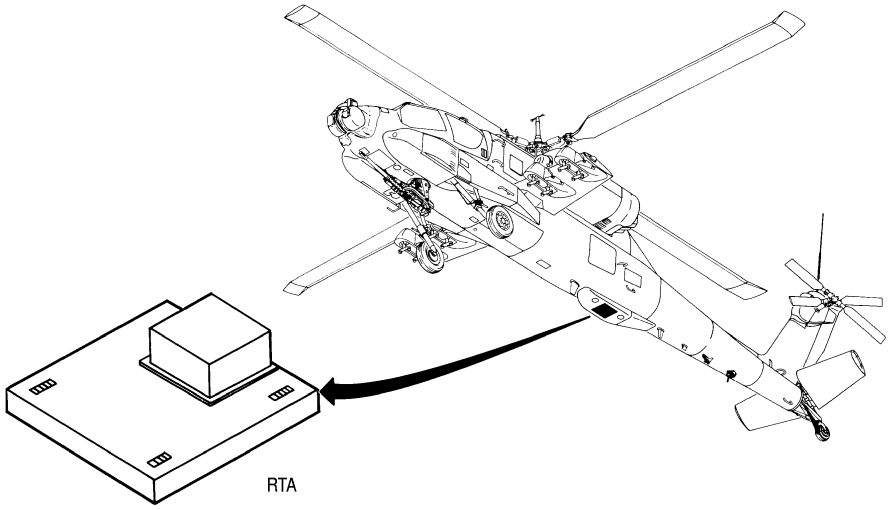
5) Line 5 - displays the PPOS of waypoint 2.

6) Line 6 - dsplays the VAR and SPH of waypoint 2.

7) Line 7 - blank.

8) Line 8 - this is the scratchpad line for data entry.

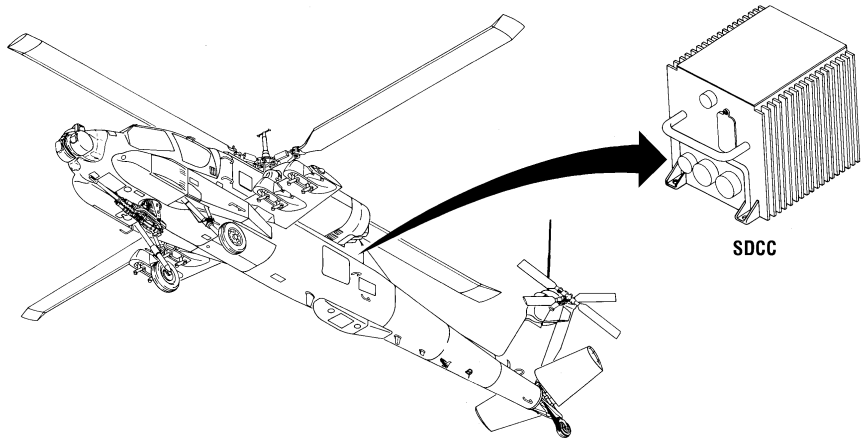
RTA LOCATION



NOTES

2. Radar receiver/transmitter antenna (RTA) RT-1193/ ASN-128. The RTA is mounted as an integral part of the doppler fairing on the bottom center of the fuselage. The RTA generates microwave energy, transmits the energy to the earth's surface, and receives the reflected energy from the surface. An antenna drip lip has been added to the doppler structure to prevent leaking fluids from contaminating the antenna.

SDCC LOCATION
CV-3669/ASN-137



21-93-05

NOTES

3. Signal data converter computer (SDCC)

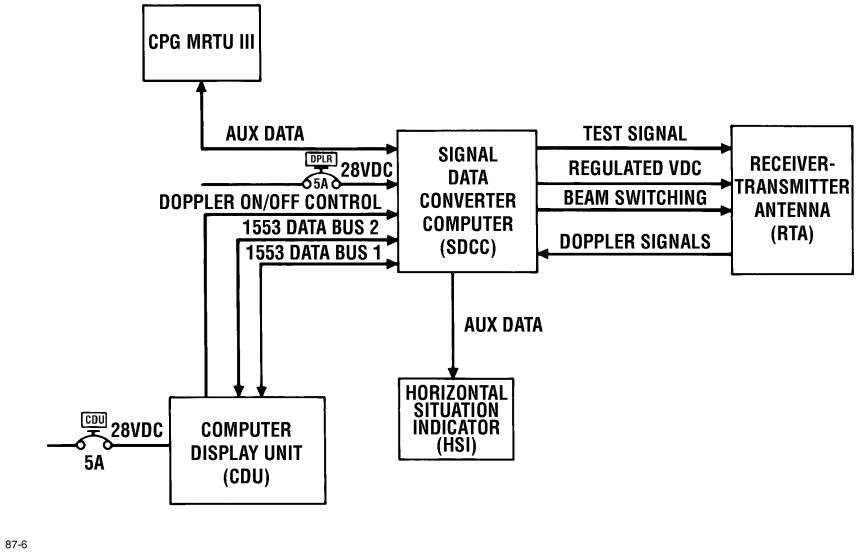
   a. The SDCC internal power supply provides regulated DC voltages to the RTA. When operating power from the mode switch is applied, the RTA transmits, then receives the radar signal to develop the doppler signal output.

   b. The SDCC converts the doppler signal into velocity information and combines it with HARS inputs.

   c. The SDCC output is supplied directly to the Horizontal Situation Indicator (HSI) and MUX bus, unlike the ASN-128 which supplies it's outputs from the CDU.

   d. The SDCC is mounted on the aft transmission deck left of the catwalk. The SDCC is a solid state line replaceable unit that performs the navigation computations for the LDNS.

AN/ASN-137 LDNS BLOCK DIAGRAM



NOTES

D. AN/ASN-137 operation

1. 28 VDC primary power is applied to the CDU via the CDU circuit breaker located on the CPG No. 2 CB panel.

2. CDU outputs the doppler ON/OFF control signal which when in the ON condition allows 28 VDC to be applied to the SDCC via the doppler circuit breaker located on the pilot forward CB panel.

3. CDU receives and transmits 1553 data bus information on two special 1553 data buses that are connected and used only by the doppler system. The two data bus lines provide a redundancy feature.

   a. 1553 data bus 1 is the primary line for the exchange of information between the CDU and the SDCC.

   b. 1553 data bus 2 is the redundant line which would be utilized if data bus 1 were to fail to provide the exchange of information between the CDU and the SDCC.

4. SDCC receives aux data which is comprised of pitch, roll, and heading information that is developed in the HARS.

5. SDCC transmits aux data which contains:

   a. Digital information to the CPG MRTU III where it is placed on the aircraft's MUX bus for processing by the FCC for fire control solutions.

   b. SDCC outputs a digital signal directly to the HSI. The HSI converts the data into bearing, distance to destination, and course deviation. It also drives the NAV and distance warning flags.

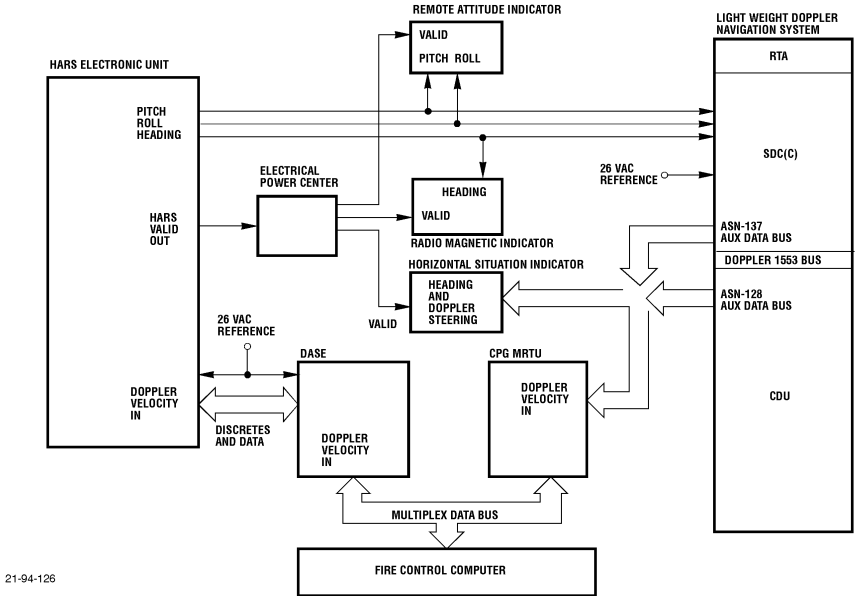
6. SDCC outputs the test signal to the RTA to check the status of its electronics.

7. SDCC outputs various regulated DC voltages to allow the RTA to operate.

8. SDCC outputs the beam switching signal. This allows the RTA to alternate between the four radiated beams.

9. RTA inputs the doppler signals into the SDCC where it computes the aircraft speed.

HARS - DOPPLER INTERFACE



NOTES

A. HARS/Doppler Interface

1. The HARS and Doppler work together to provide accurate heading, present position and bearing, time and distance to selected destinations.

2. The HARS and Doppler are interfaced together by a combination of:

   a. Discretes - circuits dedicated to full time performance of a specific function.

      (1) 26 VAC synchro excitation

      (2) Synchro information (attitude and heading)

      (3) Valid signals

   b. Data lines - data lines that are dedicated to the local transference of time shared digital information (such as the interface of the HARS with the DASE MRTU).

   c. MUX bus data - passes time shared digital information from one MRTU to another.

      (1) Connects LRU's with a minimum amount of wire.

      (2) Allows information to be processed as required before passing on to other systems.

3. HARS inputs

   a. 26 VAC synchro reference

   b. Doppler velocities from the MUX via the DASE

4. HARS outputs

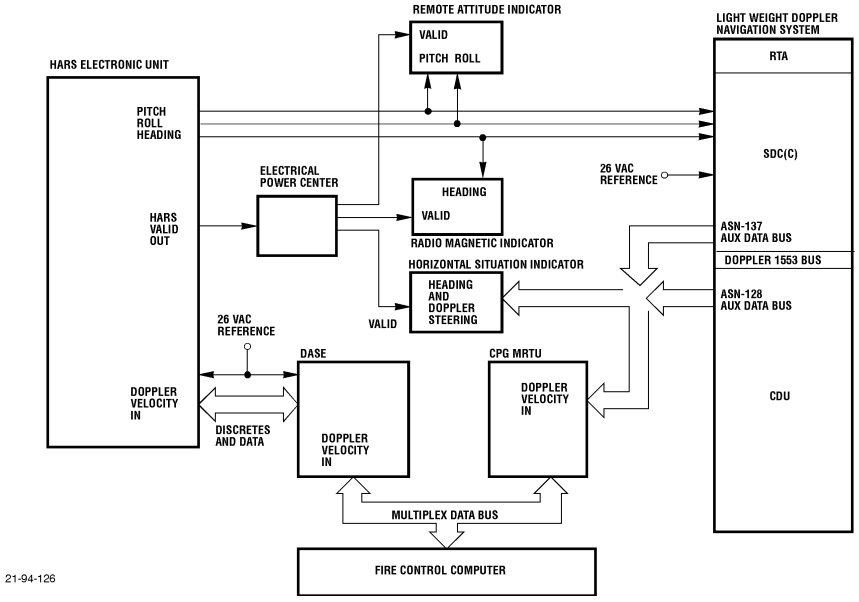
   a. The HARS provides the Doppler SDC(C) with discrete pitch, roll, and heading synchro information.

   b. The HARS provides the CPG crewstation remote attitude indicator with discrete pitch and roll synchro information.

   c. The HARS provides the radio magnetic indicator with discrete heading synchro information.

   d. The HARS provides a discrete HARS valid signal to the electrical power center for:

HARS - DOPPLER INTERFACE



NOTES

(1) DASE

(2) RAI

(3) RMI

(4) HSI

5. Doppler navigation system inputs

a. SDC(C)

(1) The HARS provides the Doppler SDC with discrete pitch, roll, and heading synchro information.

(2) 26 VAC synchro reference

(3) The RTA provides the Doppler signal and the antenna calibration constant.

b. CDU (via doppler 1553 bus) from the SDC

(1) Doppler velocities

(2) Magnetic heading

(3) Pitch and roll

(4) antenna calibration constant

6. Doppler navigation system outputs

a. **AN/ASN-128 CDU** aux data out

(1) HSI with doppler steering and range information.

(2) The CPG MRTU with doppler velocities for the HARS via the MUX.

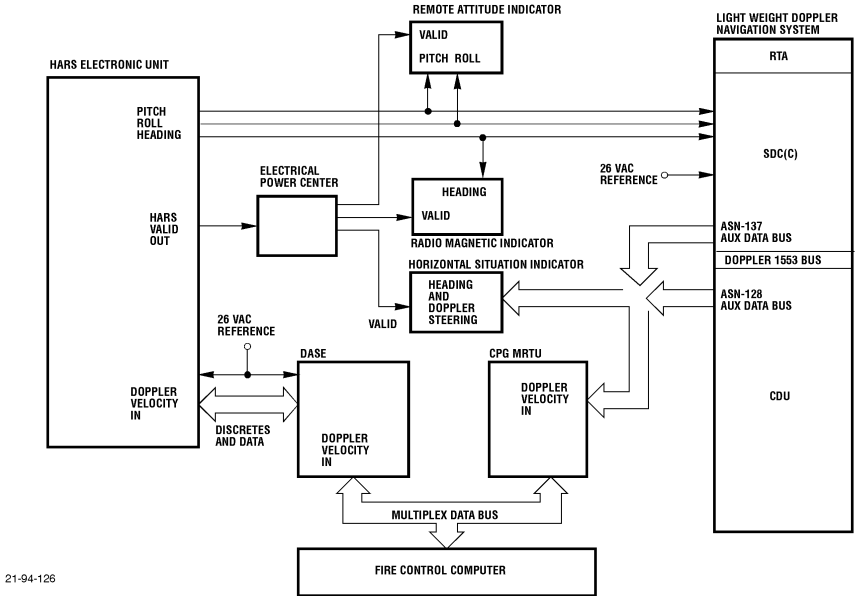
b. **AN/ASN-137 SDCC** aux data out

(1) HSI with doppler steering and range information.

(2) The CPG MRTU with doppler velocities for the HARS via the MUX.

c. The ASN-128 and ASN-137 components are not interchangeable because the aux data is provided by different components.

HARS - DOPPLER INTERFACE



NOTES

7. FCC

   a. Receives doppler velocities from the CPG MRTU.

   b. Sends doppler velocities to the DASE for use by the HARS.

B. HARS/Doppler interface operation - as the helicopter is flying from the point of origin to the destination:

1. The HARS provides discrete pitch, roll information to the RAI for visual attitude reference and heading information to the RMI for the compass card.

2. The HARS provides discrete pitch, roll, and heading information to the Doppler SDC for antenna stabilization calculations and inertial inputs to the Doppler navigation computer.

3. The HARS provides a discrete valid signal to pull the flags on the RAI, RMI, and HSI, and to DASE for flight control use, via the electrical power center.

4. The AN/ASN-128 Doppler SDC processes inertial data from the HARS and doppler radar information from the RTA and sends them to the CDU.

5. The AN/**ASN-128** Doppler **CDU** processes the inertial and doppler information to provide

   a. Accurate heading, present position and bearing, time and distance to selected destinations for navigational purposes.

   b. Sends doppler velocities to the CPG MRTU, which sends the doppler velocities to the HARS, via the MUX and DASE, for use in dampening the inertial system and increasing the accuracy of the overall navigational information.

6. The AN/**ASN-137** Doppler **SDCC** processes inertial data from the HARS and doppler radar information from the RTA and sends them to the CDU and the CPG MRTU.

   a. The AN/ASN-137 Doppler CDU processes the inertial and doppler information to provide accurate heading, present position and bearing, time and distance to selected destinations for navigational purposes.

   b. The CPG MRTU sends the doppler velocities to the HARS, via the MUX and DASE, for use in dampening the inertial system and increasing the accuracy of the overall navigational information.